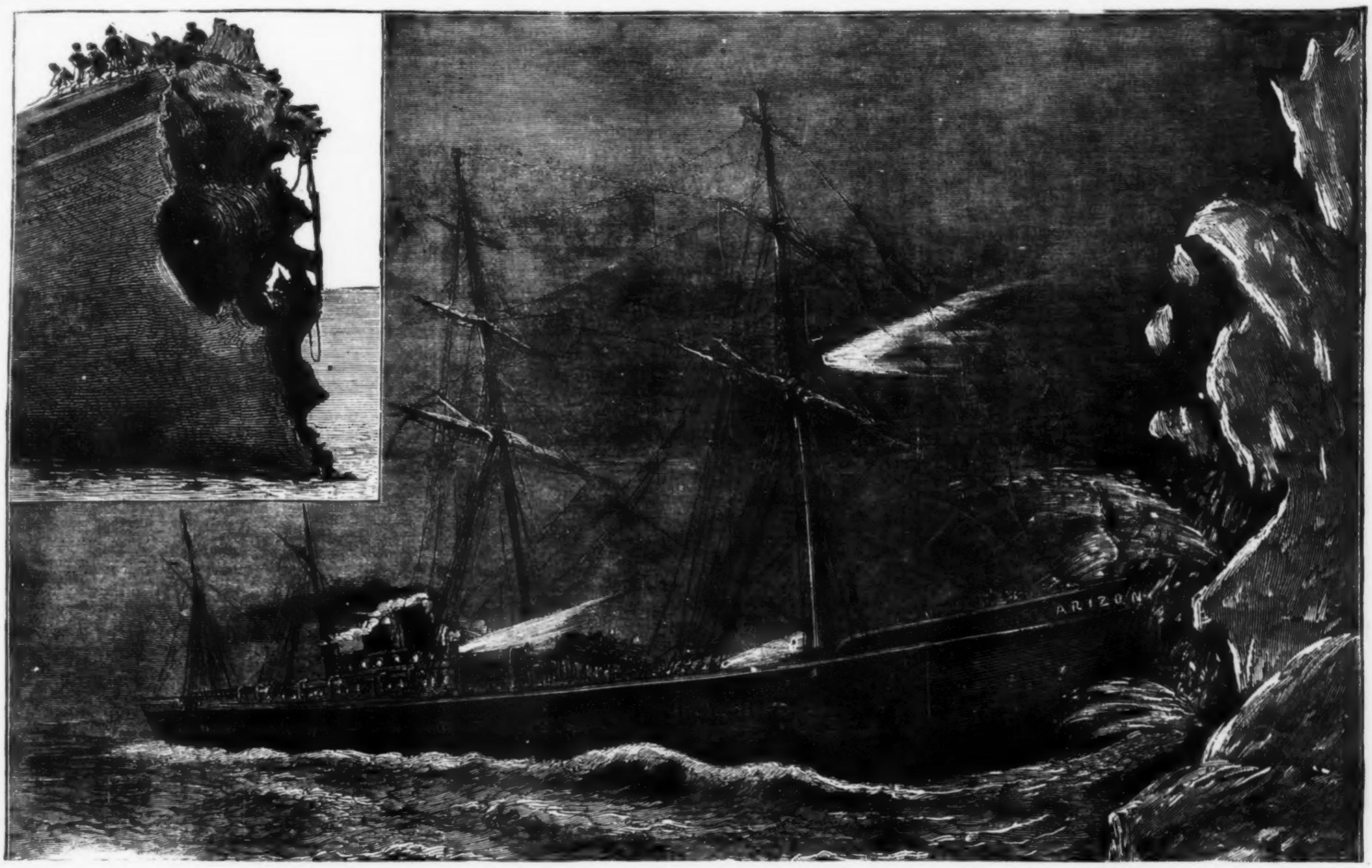
SCIENTIFIC AMERICAN SUPPLEMENT No. 210

Scientific American Supplement, Vol. IX., No 210
Scientific American, established 1845.

NEW YORK, JANUARY 10, 1880.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.



COLLISION OF THE STEAMSHIP ARIZONA WITH AN ICEBERG.

THE ARIZONA STEAMSHIP AFTER COLLISION WITH AN ICEBERG.

THE "ARIZONA."

On the previous page is an engraving taken from a photograph of the bows of the screw steamer Arizona after her recent collision, Nov. 7, 1879, with an iceberg off the coast of Newfoundland. The circumstances of the collision have been very fully described in the daily press, and it will be remembered that the vessel while steaming at about 14 knots an hour at night, and without the least warning, without even, so far as appears, the engines being stopped, ran full tilt against the iceberg, and so sustained the damage shown in the engraving. The bows were utterly crushed up for a length of about 26 ft. at the upper part, the fracture extending to about 14 ft. below the water line. We have no desire to discuss the question who was to blame for so untoward an accident, but sufficient is now known of the collision and its results to show that the vessel, with all on board, had one of the narrowest escapes on record from going to the bottom of the ocean.

We have heard of small vessels ramming icebergs without suffering much injury, but it is no discredit to the Arizona that her bows gave way, for no ship ever built approaching her size could hope to ram an iceberg at 14 knots speed without crushing in the bows. It is, however, very much to her credit and to the credit of her builders that having met with such an accident she should still have kept afloat, and be capable of reaching a port of safety. There can be little doubt that had the vessel not been very strongly and faithfully built, with material and workmanship of the highest quality, she could never have kept watertight after such a fearful blow.

It is often objected that merchant ships are very insufficiently subdivided into water-tight compartments, and this is perhaps to some extent true, although there are strong practical reasons, as may be imagined, for the present wide prevailing practice in this respect. There is one bulkhead, however, that is fortunately never neglected, and that is one forward, termed ominously the collision bulkhead, generally situated from, say, 20 ft. to 30 ft. abaft the bow. Its integrity saved the Arizona, as it has saved hundreds of other iron vessels after less serious, or at any rate less heavy collisions. The proper position for this bulkhead is often a matter of discussion, and there can be no doubt the lesson taught by the Arizona's accident is in favor of keeping it well away from the stem so as to allow the whole force of a collision to expend itself on the fore side of the water-tight bulkhead.

In this case the whole energy of the blow had to be absorbed either by the bow of the vessel or the iceberg, or both. The softer the sides of the iceberg the more work it would absorb and the less would fall upon the ship. Taking the Arizona at a displacement roughly of 9,000 tons, moving at a speed of 24 ft. per second, the energy of the blow would amount to about 80,000 foot-tons, or supposing all the work to be absorbed by the ship, it would represent a resistance of something like 3,000 tons for every foot of the bow crushed up—a force sufficient to cause rupture in 150 square inches of iron if uniformly distributed. Of course in cases of collision the force of the blow cannot be uniformly distributed, and it is impossible to do more than judge of the nature of the blow by the results produced.

The Arizona is, as our readers are aware, the last new Atlantic mail steamer. She was built by Messrs. John Elder & Co., for Mr. Guion, and was intended to beat all former vessels across the Atlantic in speed, and so to gain a preference in the passenger trade. There can be no doubt that the construction of the Arizona marks a new era in the type of our Atlantic mail steamers. In point of time she beat the Germanic and City of Berlin, and, until the unfortunate accident to which we refer, she was rapidly gaining in public favor and confidence. To this is doubtless due, in a measure, the resolution of the Cunard and Inman companies to build the enormous new vessels they have recently contracted for. The Arizona is 450·2 ft. long, by 45·4 ft. beam, and 35·7 ft. depth of hold, with a gross tonnage of 5,147. The Sahara is to be 500 ft. long, 50 ft. beam, and 41 ft. depth, while the new Inman steamer is to be 520 ft. long, by 52 ft. beam, and 37 ft. deep.

An idea of the strength of the Arizona's bow may be gathered from the following facts: The stem is of solid wrought iron, 9 in. by $5\frac{1}{2}$ in.; the plating, which is $\frac{12}{16}$ in. and $\frac{11}{16}$ in. thick on alternate strakes, is at the bow $\frac{9}{16}$ in. and $\frac{10}{16}$ in. thick alternately. There are two iron decks extending the whole length, besides other strengthening at the bow in the way of frames, stringers, and breasthooks. The collision bulkhead is $\frac{7}{16}$ of an inch thick, and about its rigidity and water tightness there can be no doubt after the test it has been put to. As we intend shortly to illustrate further the striking features of this magnificent vessel we need not further enter at the present time upon the details of her construction.—*Engineering.*

STEEL *vs.* IRON FOR SHIPS.

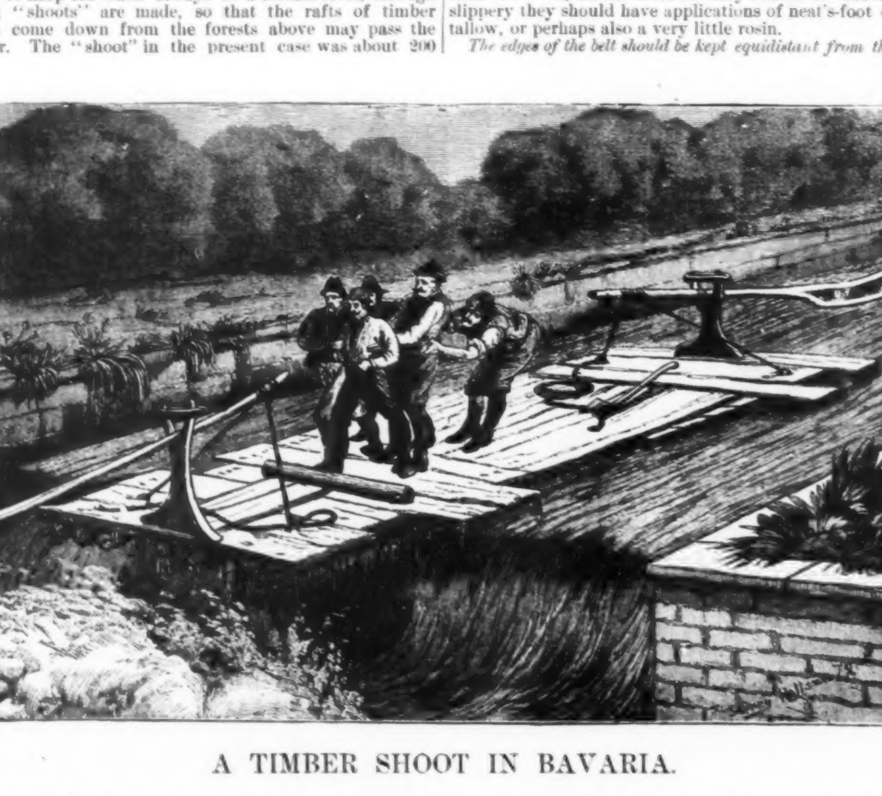
In a recent discussion on the severity of the tests applied to steel plates for shipbuilding purposes, some members of the Iron and Steel Institute seemed to possess a half-expressed opinion that collisions between ships are hardly of sufficient frequency to make it desirable that particular attention should be paid to the choice of material for ships, in order to be prepared for this particular class of accident. Steel, it was said, could not fairly compete with iron for shipbuilding because it is unfairly tested as compared with the iron used for the same purpose. The tests imposed, it was alleged, made it absolutely necessary to produce a very mild steel at a comparatively high price, but with mechanical properties not much better than those of iron, and not so good by a great deal as those of steel of a somewhat harder nature, produceable at a much lower cost. The very mild metal was urged by one party to be essential to the construction of trustworthy ships of steel, it being desirable that the plates should buckle or bend rather than break under impact strains. On the other hand, it was contended that steel plates of moderate hardness could be made which would still withstand shocks due to collision. It has also been said that probably when fracture did occur with such steel plates it would be more likely to be local, that less real damage would be done than with plates that would bend and buckle a good deal before breaking.

The appearance of the bows of the steamship Arizona, which came into collision with an iceberg in the Atlantic, on the 7th Nov., 1879, 240 miles off the coast of Newfoundland, redirects attention to this question. In this case, the velocity of the ship, about 22 ft. per second, was gradually though quickly reduced to 0, by the work dissipated in bending, crumpling, and breaking the stem, frames, and plates, these parts acting as a cushion between the main body of the ship and the iceberg. Now, these plates were of iron, and though it may be presumed that they were of a good quality for ship plates, they nevertheless were ship plates. Being of iron they were of the thickness and weight required by the rules relating to ships of that material. They were thus considerably heavier than they probably would have been if made of the mild ship-plate steel, or of that of a harder nature, proposed by Bessemer steel makers for use for the purpose. These iron plates and framework were very severely tested in bringing the vessel to rest from a speed of over thirteen knots an hour. They seem to have done as much breaking as bending, though it must be remembered that the high velocity of impact was very favorable to the former. Now it becomes a question worthy of consideration whether either the very mild steel or the somewhat harder steel would have behaved so well under this very severe practical test. It must not be forgotten that when steel plates and framing are used they are lighter than iron. Steel under such a test is thus obviously at a disadvantage as compared with iron. Though a harder and stronger material, it is questionable whether any but the smallest reduction in thickness would not be attended with great loss of effective strength under the conditions of the iceberg test. Thickness in such a case would be an important element of strength. The resistance to buckling in the first phase of the shock which this would secure would be much in favor of the heavier bows and frames of the iron ship. It could, of course, be easily shown that very thin steel plates are sufficient to meet all the ordinary strains brought to bear upon a ship's bows; but at the same time it will be admitted that the buffer which stopped the Arizona would double them up as though of cardboard, and deliver the undiminished force of the collision farther into the ship. The experience of the Arizona does not suggest that a stem should be of strength sufficient to run full tilt at an iceberg without damage to itself, but rather that it should be sufficiently strong to act as a cushion, as it crumples and breaks up under a very severe shock. The question remains, Will there be any advantage in using steel for the stems of ships if it must be as heavy or nearly as heavy as iron, to be equally effective under all the contingencies of ocean voyages?

To enable our readers to realize to some extent the nature of the injury suffered by the Arizona, we give on first page an engraving of the ship as she lay in St. Johns, Newfoundland, copied from a photograph taken by Mr. S. H. Parsons, and forwarded to us by Mr. George Pitts. The Arizona carried away about 26 ft. of her bows in the line of the topgallant forecastle deck, and to a depth of 14 ft. below the water line; the collision bulkhead saved her from foundering. She is to be fitted with a temporary wooden bow above the water line, and a temporary iron one below.—*The Engineer.*

A TIMBER SHOOT IN BAVARIA.

The rivers in the flat parts of Bavaria are obstructed by weirs, to keep the water always at a certain level, through which "shoots" are made, so that the rafts of timber which come down from the forests above may pass the barrier. The "shoot" in the present case was about 200 yards long by 7 or 8 wide, boarded at the bottom and sides, down which the water rushed from the higher to the lower level.



A TIMBER SHOOT IN BAVARIA.

Presently we heard a cry from above, "A raft is coming." We waited, and before long we saw a mass of timber, with four or five men on it, one with the long steering-oar in his hand, preparing for the plunge. It came slowly on until the incline began, when the speed increased and soon became tremendous. An error in steering would have been fatal, as, if the raft had swung round, it would have jammed against the sides, and the men must have been washed off. However, this one went smoothly enough down the incline until it came to the end of the planking, when there was a sudden drop of three or four feet. Here the men took firm hold of each other, while the raft took the leap, and went bumping and tumbling about as if it were coming to pieces every minute, until it got past the surf, and safely into the smooth water beyond. It was most exciting to watch, and must be quite an event in the monotonous lives of the raftsmen. Our engraving is from a sketch by Mr. P. Sidney Holland.—*London Graphic.*

A transparent cement of extreme tenacity and serving excellently for joining fragments of wood, porcelain, glass, or stone, is made by triturating in a mortar 2 parts of nitrite of lime with 25 parts of water and 20 of pulverized gum Arabic. After the application of the cement, the fragments should be held together by a rubber band of string until perfectly dry.

PULLEYS AND PINIONS FOR MILLSTONE SPINDLES.

By Charles B. Coon, B.S., Burdett, N. Y.

Only second in importance to the balance of the stone and the condition of the driving irons, is the manner in which the spindle is propelled. If the motion is perfectly regular and unvarying, and the mill is provided with good apparatus, the miller may blame himself for whatever poor flour is made; but with a spindle that moves like the breaker in a plaster mill who will expect to produce good work?

The first point in the care of a belt or a pinion, then, is to secure smooth, uniform action. Let us suppose, in the first instance, that we have

A SPINDLE DRIVEN BY A BELT.

First the pulley should be large and narrow—not less in diameter than four-fifths that of its driven burrs, and moved by a belt of a width which shall conform as strictly as possible to the size and speed of burrs and the rate of grinding. As an example, a 4 ft. stone at 140 revolutions, and grinding six bushels of medium quality wheat per hour, should have a belt six inches wide and a spindle pulley forty to forty-four inches in diameter. If the speed is greater than 140 and the rate of grinding unchanged, the belt may be somewhat narrower; if the speed is less and the rate of grinding still the same, the belt should accordingly be wider.

The pulley must be adjusted to the most perfect balance, which is the business of the machinist who makes it. Perfect tram is utterly impossible with a pulley that vibrates the tram-pot and wears the point on one side.

The belt should be thin and even. Double belts for spindles belong to a past era of milling. If the belt is thin it will wrap the pulley more closely for any certain degree of tension by the tightener, and less power will be lost in bending the belt and also in overcoming its centrifugal action. But far more important is the fact, that the thin belt is less liable to put the spindle out of tram. In view of the last consideration, and likewise that of uniform motion, the belt ought to be as even in thickness and quality as art can make it.

The grain side of the belt goes next to the pulley. For this are the following reasons: first, the grain side is smoother and more even than the other, and will cover more surface of the pulleys; consequently the belt may be run more slackly with the grain next to the pulley; secondly, as the flesh side is the stronger, it should not be worn out while the grain or weaker side is left.

The tightener should not be overstrained. It should cover the belt only sufficiently to prevent the latter from either slipping or vibrating.

The belt should be kept soft and pliable. No rule can be given for this purpose. New belts usually need a little neat's-foot oil, and as often as they stiffen or become too slippery they should have applications of neat's-foot oil and tallow, or perhaps also a very little rosin.

The edges of the belt should be kept equidistant from the edges of the pulleys; otherwise one edge becomes stretched more than the other, the belt then wraps the pulleys with unequal tension at its edges, friction surface is lost, the tightener must overcome this defect by overstraining, and the belt is soon unfit for use.

The belt should never be kept strained when idle, otherwise its elasticity is soon destroyed.

Let us now consider

A SPINDLE DRIVEN BY A PINION.

First, the pinion should be a cut gear; for if it is not, years of wear are requisite to bring the teeth to smooth, even, mathematically curved faces. Without such correct faces on the cogs neither perfect granulation nor perfect grinding can be accomplished, even with the aid of springs on the spindle.

The pinion should have nearly half the diameter of its driven burrs. For instance, a pinion should not measure less than twenty-two inches to drive a 4 ft. stone. The larger the pinion, the less the force applied at its periphery to do a certain amount of work, and hence the less strain on the spindle, with consequent decreased loss of power by friction and a slighter tendency to strain the spindle out of tram.

The pitch of the cogs should be as fine as is consistent with the safety and durability of the spurs; I would say, never less than $1\frac{5}{8}$ inches nor more than $2\frac{1}{8}$ inches for 4 ft. burrs, and between those limits my preference would be $1\frac{3}{4}$ inches pitch.

The spurs should be lubricated frequently, and they ought to

be tightened by the keys whenever they chatter; for otherwise the pinion soon ruins the spurs, or at any rate the force communicated to the burrs is sufficiently irregular to deteriorate the quality of the flour.

The bed stone should be leveled before every operation of tramming, not only for the obvious and abundant reasons usually considered, but also in order to keep the faces of the teeth vertical and preserve the exact tangency of the pitch circles. Whenever the cogs are discovered working off from the proper pitch line the bed stone ought to be moved so as to bring the pitch circles just tangent. This is very easily calculated and accomplished, and I will offer the following method which I have used and know to be satisfactory in its results.

Find the circular line traversing the top ends of the pinion teeth, or the prick-punch marks placed there by the machinist who laid out the cogs, or in the absence of both, find as accurately as possible the center of the raised portion of the tooth at the upper or the lower end of the tooth. In this manner ascertain the exact diameter of the real pitch circle of the pinion by measuring across it or measuring from the circle to the spindle, adding one-half of the diameter of the latter and multiplying by two. The remainder of the operation may now best be explained by a practical illustration. We have measured this pinion, let us suppose, and found that the pitch circle is precisely 19 inches in diameter. The ratio of any circle's circumference to its diameter is 3·14159 +; therefore

$$19 \times 3{\cdot}14159 = 59{\cdot}69021$$

is the circumference of the pinion's pitch circle expressed in inches. The pinion has 28 cogs, therefore the circular pitch is

$$59{\cdot}69021 \div 28 = 2{\cdot}13179 \text{ inches.}$$

Supposing that the spur-wheel which drives this pinion has 114 spurs, the circumference of its pitch circle is

$$114 \times 3{\cdot}13179 = 243{\cdot}02406 \text{ inches;}$$

therefore its diameter is

$$243{\cdot}02406 \div 3{\cdot}14159 = 77{\cdot}357 \text{ inches.}$$

Our object is to establish a tangency of these two pitch circles, and therefore we wish to measure off a semi-diameter from the center of the spur-wheel to the point where the pitch circle of the pinion ought to work. The semi-diameter (or radius) of the spur wheel's circle is

$$77{\cdot}357 \div 2 = 38{\cdot}6785 \text{ inches.}$$

But we cannot get a measuring stick to the center of the spur-wheel, because the shaft is in the way; and thus we must accurately calibrate the shaft. We find it is 6·6 inches in diameter.

$$6{\cdot}6 \div 2 = 3{\cdot}3 \text{ inches,}$$

the distance from the outside of the shaft to the center,

$$38{\cdot}6785 - 3{\cdot}3 = 35{\cdot}3785 \text{ inches,}$$

the distance from the outside of the shaft to the point where the pitch circles should touch each other, and this can best be found by laying off the $35\frac{3}{8}$ inches on a straight stick having a square end to abut against the shaft. The pinion is then moved in or out of gear until it is just right. Any miller who is wholly fit to superintend a flouring mill can readily do what has here been described, and he will usually perform such work more accurately, and therefore with more pleasing results, than most of the millwrights, for he appreciates the supreme importance of having it perfect. He knows that the bolts and conveyors and elevators may be propelled by gears that wabble like a run-down top and warble like a Chinese orchestra, but he further knows that the spindle pinions must act smoothly, uniformly and silently.

There are several scientific forms for the teeth, of gears, and millers should never place pinions on millstone spindles without knowing that the teeth were laid out under the direction of a machinist versed in the mathematics of gearing.

In the foregoing remarks attention has been called to some of the points which millers are too frequently disposed to overlook. By observing such trifles and using the proper machinery, low grades of wheat may usually be milled at a good profit, while a disregard of these minutiæ of the trade must entail indifferent success, even with the best of grain.—*American Miller.*

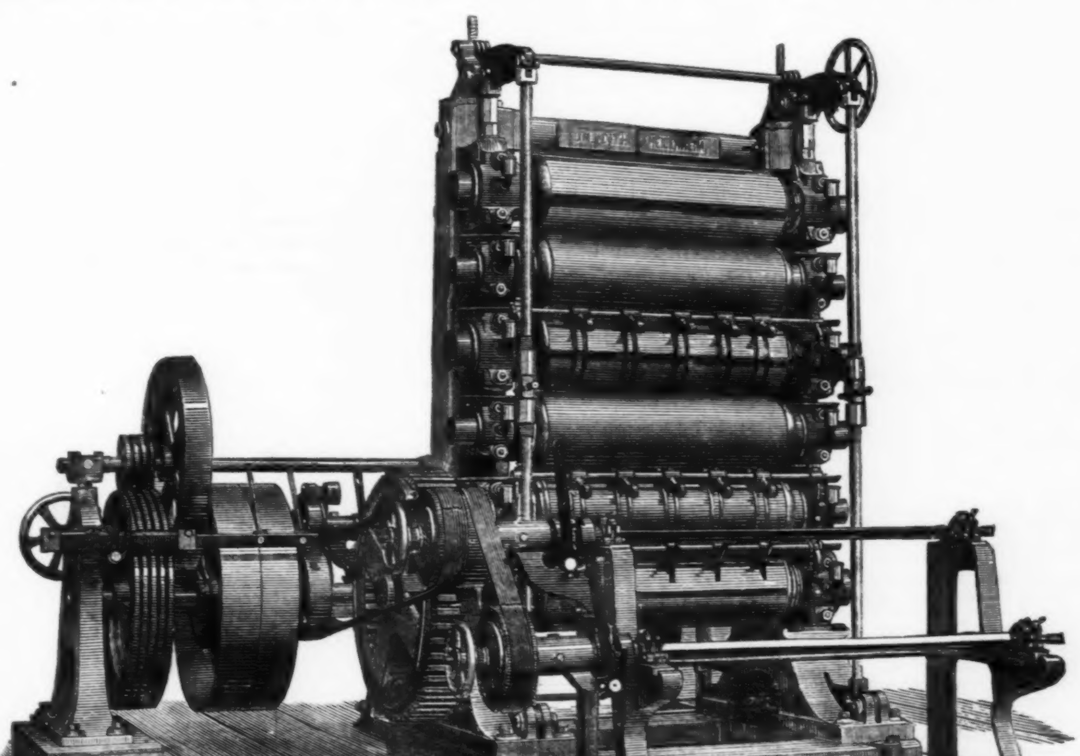
APPARATUS FOR THE MANUFACTURE OF ARTIFICIAL SANDSTONE.

THE principal substances employed in the manufacture of artificial sandstone by a process recently invented by M. Zernikow, are quartz sand and slaked lime. All the varieties of sand which, when mixed with the slaked lime, produce mortars that are capable of readily absorbing water, are suitable for this purpose; nevertheless, fine sand containing the greatest amount of pure silica is preferable. The materials may be mixed in any proportion suitable for the preparation of mortars; but the artificial substance is generally harder in proportion as the mortar is thinner; a mixture formed of from four to six parts of sand to one part of lime produces a sandstone of excellent quality. The sand and lime must be mixed very intimately together, in order to constitute a perfectly homogeneous mass. For this purpose, machines may be employed such as are in large towns for mixing mortar, or good machines as used in brick manufactories for working clay. When the thin mortar thus obtained is baked for several days in a closed steam-boiler, it forms, under the influence of the temperature and of the pressure, and at the points of contact between the lime and the sand, a thin layer of silicate of lime, which determines the hardening of the mass when the temperature is lowered below 212° F., and when the pressure diminishes at the same time. As all the particles of lime are not transformed into silicate, the mass continues to harden by the absorption of carbonic acid from the air, and at the end of a few weeks the artificial stone thus acquires a hardness equal to that of sandstone of the best quality. The process devised by M. Zernikow depends upon the employment of steam for the purpose of accelerating the induration of the mortar. The mass as it comes from the mixing machine is introduced into a special apparatus, and is delivered by a tube to a press, which gives to it the required form. The baking may take place by the agency of steam proceeding from the boiler, by which means the necessity is obviated of employing a special stove connected with the apparatus. As the chemical combination between the silica and the lime takes place only at the points of contact between the two substances, and consequently proceeds gradually, the operation lasts some time, and is divided into two periods: the first of which comprises the heating of the mass, and the second, which is prolonged during several days, the raising of the steam to the required temperature. The mass is introduced into a vertical boiler through a man-hole, which is thereupon closed tight. In the axis of the boiler is a hollow shaft, the upper part of which is connected by means of a stuffing-box with the tube that admits the steam, and carries at its lower end a number of horizontal perforated tubes, disposed in the form of a screw. On opening a cock in the steampipe, the steam from the boiler passes into the stuffing-box, and down the hollow shaft, and escaping through the small openings in the horizontal tubes, penetrates the mass. The steam gives up first its latent heat, and then, after suffering condensation, a portion of its free heat corresponding to the difference of temperature, and the mass thus becomes continually heated until it has attained the temperature of the steam. The water produced by the condensation of the steam passes to the upper part of the boiler, in consequence of its comparatively lesser density, and accumulates above the mass; it is allowed to run off by a cock, and is employed in a second operation, by which means not only the heat is utilized, but the particles of lime which it holds in solution is saved. A manometer, fixed on the cover of the boiler, enables the moment to be ascertained, when the heating of the mass has reached such a point that the steam introduced into the boiler ceases to part with any of its heat. As soon as this is the case, the direct admission of steam is arrested by closing the steam-cock. It is now necessary to maintain the mass for several days at the same temperature and under the same pressure; for this purpose, the boiler is surrounded by a second boiler or shell, a space of $1\frac{1}{2}$ in. or 2 in. being left between the two. This space is closed at the top, and communicates by means of a tube with the steam-pipe, so that by opening a cock, the space between the two boilers becomes filled with steam, thus preventing the cooling of the inner boiler and its contents. The steam in the envelope becomes partially condensed, in consequence of the radiation of heat from the exterior; an indicator serving to show the level attained by the condensed water, which is returned through a tube into the steam-boiler, on opening a cock. The baking of the mass is prolonged for about three days, at a pressure of from eight to four atmospheres; in this manner there forms on the surface of the grains of sand a film of silicate of soda; besides which, the sand loses its hardness and resolves itself into a more plastic mass. The hollow vertical shaft is capable of receiving a rotary motion by means of a pully fixed to its upper part; this movement should at first be slow and periodical, as long as the duration of the first part of the operation, and should become more rapid and continuous, when the mass shall be run out into the moulding-machine by opening an outlet-pipe at the bottom of the apparatus. The mass, which is composed of the most part of silica, silicate of lime, hydrated lime and water, disengages sufficient steam, when the cock placed on the cover of the apparatus is opened, to cause the temperature to descend below the boiling point, and the pressure to diminish in the same proportion, and the mass attains the desired degree of dryness, so that it may be moulded and retain the form that it has received. The apparatus has an internal diameter of 5 in: it may be filled up to a height of about $11\frac{1}{2}$ ft., so that it will contain some 225 cubic feet of matter. Such an apparatus is capable of producing in three days 925 ft. of window-dressing about 7 in. wide and 5 in. thick, or sufficient for 50 windows each measuring about 3 ft. 3 in. wide by 6 ft. 6 in. high. The net cost of production of the artificial sandstone by the process above described is as follows:—1 cubic meter (about 35 cubic feet) of thin mortar —8fr. to 10fr. (6s. 5d. to 8s.) Heating to 266°—284° F. (three or four atmospheres), and maintaining at that temperature for three days, 4fr. (3s. 2½d.) Moulding and transport, 4fr. to 6fr. (3s. 2½d. to 4s. 10d.) Total, 16fr. to 20fr. (12s. 10d. to 16s.)

IMPROVED CALENDERING ROLLS.

WE illustrate a new arrangement for mounting the rolls of calendering machines devised by Mr. F. Voith, of Heidenheim, Wurtemberg. This arrangement is, we believe, largely in use in Germany. The principal part of the arrangements refers to the adjustable bearings for the rolls. In the drawings, Fig. 1 is a front elevation of the calender; Fig. 2 is a vertical section, and Fig. 3 is a horizontal section on the line *x x*, Fig. 2. The general arrangement of the set of rolls and gearing for driving them is shown by the views below and on next page.

The roll supports consist of two standards, A and B, cast hollow, and bored out exactly perpendicular to the foundation plate, and each of them has a slit on the side toward the rolls. In these bored standards there is inserted for each bearing a cylindrical turned sliding piece, D. On one side of the latter a segment is cut away in such a manner that a plane parallel to the axis of the cylinder is formed, which plane is rather narrower than the slit in the frame. Against this plane the bearing, E, is held by a bolt or bolts; at the same time a pin, F, or the bearing fitting accurately into a hole bored in the sliding piece, prevents any pushing apart of the two pieces, while allowing them to turn freely. This construction is intended to secure the following advantages: The rolls can be quickly changed, and there is easy accessibility to all the moving parts and to those subject to wear. Every single roll may be removed by loosening the bolts

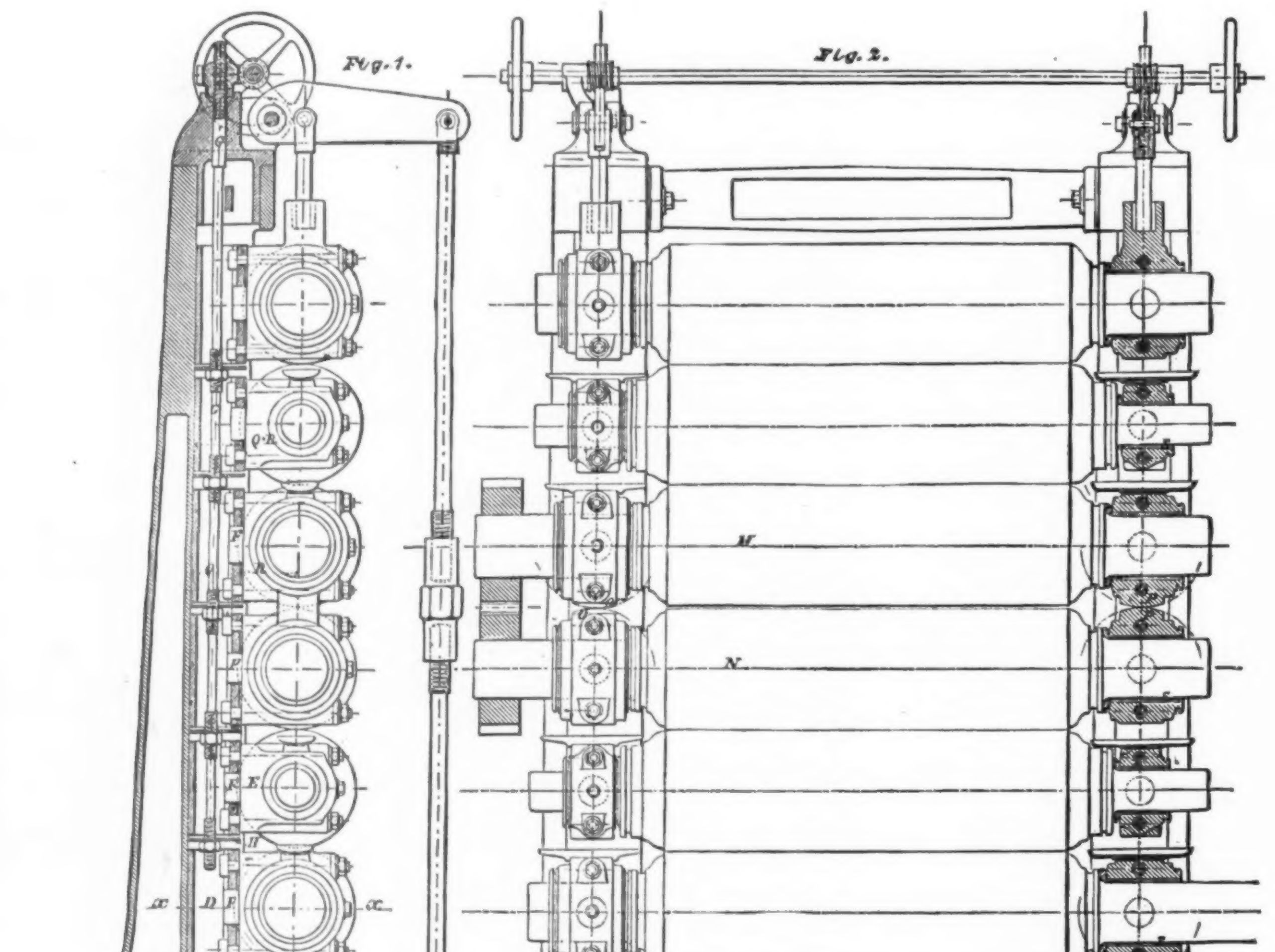


VOITH'S CALENDERING MACHINERY.

which connect the bearings to the two sliding pieces, whether for re-turning or re-grinding, or to repair or renew the bearings. The rolls lying above that one to be taken out must be held fast, and they may be easily so held by the lifting screws, G; these lifting screws pass through all the sliding pieces, and by means of the washer, H, and the nut underneath it, every sliding piece, that is to say, every roll, can be lifted up from its neighbor and held till the roll which has been taken out can be returned or replaced with a spare one.

Every roll bearing is a so-called universal bearing, that is to say, it can turn in all directions, and adapt itself exactly to the journals of the rolls; an arrangement devised to prevent heatin , to diminish friction, and the wearing away of the bearing and journal. The lower bearing lies on a planed surface, K, of the standard, and has its lower surface turned concentric with the journal, F, and has therefore the same advantages as the others. If, as shown in the drawing, there are two rolls, M and N, which do not work directly on each other as in paper calenders with four chilled and two paper rolls, the surfaces, O and P, are turned exactly to the same diameter and concentric with the journal, F, and fit in the cylindrical holes bored in the standards, and are afterward fastened to a face plate against an elbow, and are faced on the slide, and the hole for the pin, F, is bored. By this operation, the plane faced on the sliding block must be made exactly parallel with its axis.

The sliding blocks must all be of the same height, or the distance, Q, must be the same for all the sliding blocks. This is the only point where exact measurement is necessary to insure perfection of the machine, or rather the exact parallelism of the rolls. On the bearing, E, the side which is to be bolted against the sliding block is first faced off, and at the same the pin, F, is turned. Then all the bearings one after another are fixed on an elbow on the face plate, and bored to receive the brass linings, and faced off. The elbow has in it a hole, in which the pin or the bearing fits, and when the elbow remains the same for all the bearings, the distance, R, will remain absolutely the same for all, and their accuracy is really independent of the care and skill of any workman. If through want of skill on the part of the workman the elbow should be so placed that the center of the pin, F, prolonged does not meet the center of the lathe, this has no influence either upon the parallelism of the rolls or upon the flexibility of the bearings. The distance of the center of the rolls from the middle of the cylinder in the standard is exactly alike for all the rolls, and is the sum of Q + R, minus the radius of the sliding block.



VOITH'S CALENDERING MACHINERY.

thereby the exact parallelism of the rolls and the flexibility of the bearings, as well as the weight of all on the lower roll, are insured. By this method of construction the side pressure, which the rolls when in operation exercise on the bearings, is reduced to a minimum, and has no influence upon the proper position of the bearings, as in the ordinary construction in use, especially with machines which have very high frames for eight or more rolls.

All of the rolls lie exactly parallel, that is to say, the axes of all of the rolls lie exactly in the same plane. This is a necessary consequence of this method of construction, and is easily attained without special expenditure of time and labor, and without the services of specially skilled workmen. The standards can be accurately bored on any suitable lathe by means of a special boring bar; at the same time the feet of the standards can be turned off perpendicular to the axis of the boring bar by means of a slide rest secured to the face plate of the lathe. Then if the two standards are laid on a solid bedplate, which has been well planed or turned, it is evident that the axes of the two cylindrical holes bored in the standards must be exactly parallel with each other. The sliding blocks, D, are turned to

The bushes, S, of iron or brass are turned and bored, complete, and forced in the iron bearings. It is obvious that the value, Q + R, is in no way altered, and if their bushes require renewal the parallelism of the rolls will remain the same.—*Engineering.*

PURIFICATION AND EXTRACTION OF SUGAR JUICE.—The yield of crystallizable sugar is said to be increased, and the amount of molasses diminished, according to a French patent, by treatment with tannin, by adding to the juice immediately after its extraction oak-bark, gall-nuts, or catechu to acid reaction, and boiling. After clarification and concentration, a sufficient quantity of decoction of oak-bark is added to the filtered juice to neutralize the alkalies. The clarification with lime, the concentration, and treatment with the decoction of oak-bark are repeated.

SCOURING WOOL BY NAPHTHA.

As manufactures and their processes progress to increase and cheapen production or to save waste, the status of fire hazard changes. One of the most recent evidences of this is shown in a report of considerable length, addressed to the president of the National Association of Woolen Manufacturers, and published in their Bulletin for the second quarter of 1879. The subject of the paper is the discussion of the merits—with details of experiments—of the naphtha process of scouring wool, and saving the valuable secretion in the fiber, which has heretofore been almost all wasted, at least in the United States. In its natural state, this secretion is a yellowish matter, generally called grease—by the dealers, yolk—and is really a partial soap (a soap with an excess of oil), composed largely of alkali; it also contains cholesterin (a non-saponifiable fat), iso-cholesterin, and another analogous alcohol. The average quantity of strictly clean wool obtainable from all qualities of fleeces is about 45 per cent., and allowing 5 per cent. for sand, etc., there must be at least 112,500,000 pounds of this yolk in the 250,000,000 pounds of wool, which is now the annually estimated quantity for the United States alone, besides the imported wools, most of which are unwashed, some of them containing 65 to 80 per cent. of grease and dirt.

Several processes to effect this saving have for years past been tried in France, England, and Belgium, but they were difficult, expensive, and required extensive space, settling tanks, etc. The recovered grease has been found "to be equal to the best for tanning purposes, and not at all subject to spontaneous combustion." With present washing, the non-saponifiable fat has been chemically extracted from the water to make candles. If worth only 2c. per lb., it has an annual value of $2,500,000. It is not surprising that intelligent manufacturers should desire to save such an important item of annual waste, and those who have the charge of streams furnishing water for cities are anxious to protect them from receiving such noxious drainage. The Philadelphia Park Commissioners have lately commenced legal action against the owners of large woolen mills emptying this refuse and waste dye-stuffs into the Schuylkill river.

The experiments detailed in the report mentioned are based upon a French process, and the quality of naphtha used is

what is called gasoline, having a proof rate of 86° F. The wool is placed in a close vessel, and naphtha poured upon it, and allowed to remain for twenty minutes, without use of heat, in several separate applications, according to the condition of the wool treated. Naphtha of the quality indicated boils at a temperature of 90° to 100° F., and air of 50° or 60° F. completely removes it. In a large way, and for more rapid volatilization, "a current of warm air would be passed through." After the cleansing, the wool is washed in pure water only, aided by the potash which has remained in the fiber.

The advantages claimed for the naphtha process over other plans for such saving of waste, are: More perfect cleansing of the wool, better condition of the fiber for reception of dyes, fewer fixtures and less space needed, more rapid recovery of the grease, and the restraining of it more easily from polluting streams. The only disadvantage is the inflammable character of the naphtha, with its vapor uniting with the atmosphere in explosive proportions, requiring a separate building for the process. The report says, on this important point: "This is not an insurmountable obstacle, as the use of the substance for several industries has been perfectly successful." The fire jeopardy is, however, insurmountable, but it has a minimum, to which it can be reduced. The process is a good and desirable one, and appears to be compensatory of extra fire hazard. It is, however, much complicated by the temptation to use too high temperature in order to hasten the evaporation, and by the probable negligence or unskillfulness of workmen. While the cost and the time required are so much less in this than in the other processes that large woolen manufacturing concerns especially must be tempted to adopt it, the manufacturer dislikes to have the wool cleansing house distant from the dye house, and the latter he always wants immediately adjoining the factory. The inclination, therefore, would be to have the cleansing building for the naphtha process on the same lot as the other buildings, and the temptation to locate it too near the principal factory buildings almost irresistible. But even here the question is the grade of hazard and the premium rate.

Our woolen mills burn now an average value of about $800,000 per annum. The wool scouring, *per se*, at present contributes but little to such annual loss; but with the substitution of naphtha for water, the scouring becomes the highest hazard of the general wool mill risk. Still, if the process save, say, $2,000,000 of value annually, there would be a profit in it, should it double the fire cost of woolen mills. It will be the business of the underwriter, however, simply to measure the respective rates of burning which the manufacturers shall permit.—*American Exchange and Review.*

UNDERGROUND LONDON.

FEW Londoners have any idea of the vast and complicated network of passages and channels beneath their feet in connection with railways, subways, the telegraph, water, gas, and sewerage or drainage. There is much that is interesting in this "underground London;" but perhaps one of the most curious and weird sights that belong to it would be seen by making a descent into one of the large "Penstock chambers," situated at various points on the main drainage system. One of these slimy and not over pleasant "chambers" is represented in our illustration. The "Penstock" at the right hand of the engraving is a great iron gate, which can be lowered, like a portcullis, by machinery, so as to shut up, or direct into other channels, the dark current of sewage which rushes from the circular brick tunnel below. These "Penstocks," of which there is a large number in use, are most essential to the proper regulation of the drainage, not only when things are going on as usual, but in the event of any mishap occurring, or in the case of sudden floods, occasioned by an exceptionally heavy and rapid rainfall.

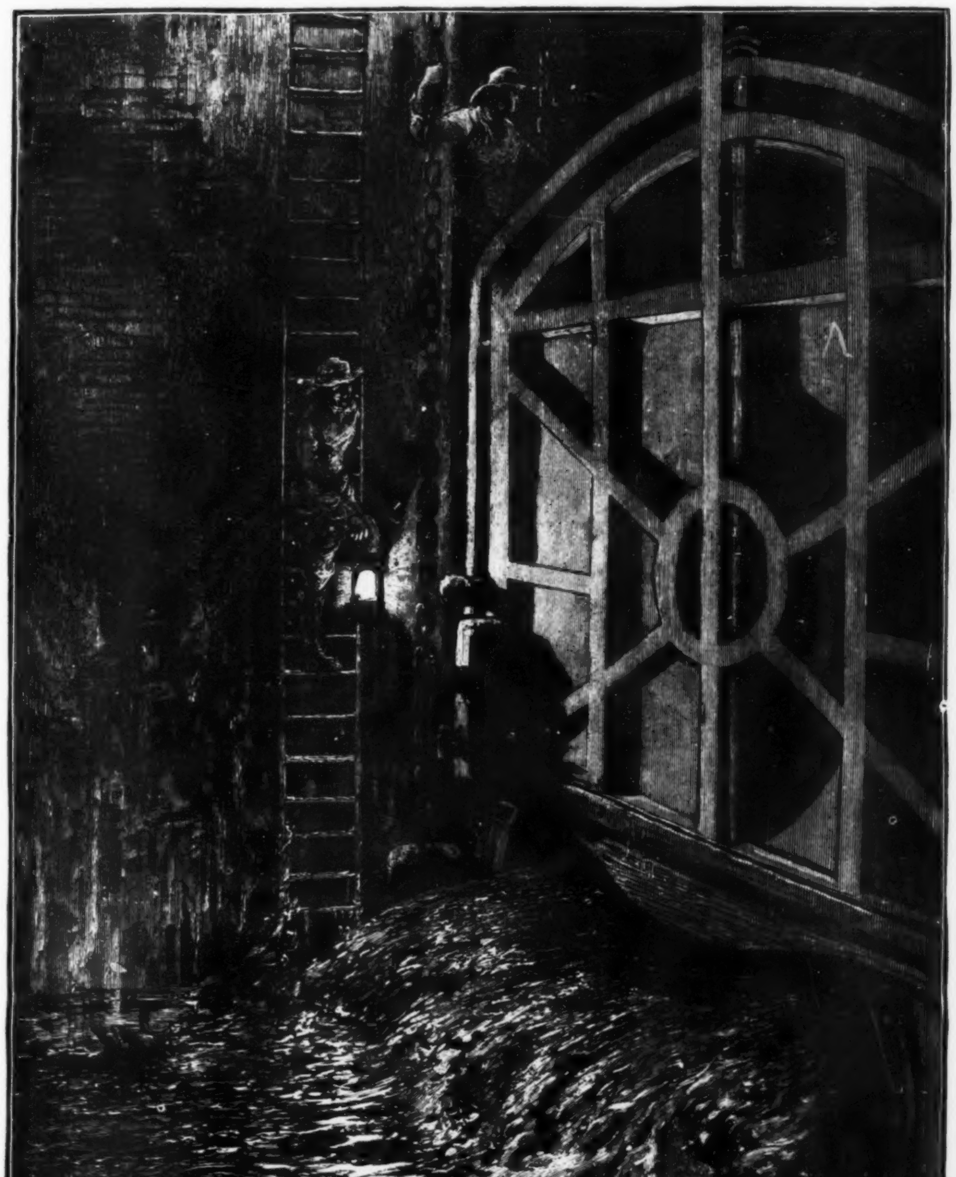
The system of Metropolitan Main Drainage has often been described in this journal. It is, beyond question, the grandest and most perfect work of its kind that has ever been devised. Provision is hereby made for the secure reception and conveyance of an aggregate quantity of liquid and mixed matter, including the average surface water from rainfall, amounting to sixty-three million cubic feet daily. That is equal to a lake three feet deep, fifteen times as large as the Serpentine, or nearly as large as the whole of Hyde Park. The portion consisting of water from rainfall, on the north and south sides of the Thames, is nearly forty-six million cubic feet daily, while the sewage liquid, composed of water from houses, mixed with refuse solid matter, is above seventeen million cubic feet. Two-thirds of this sewage belongs to the north side, which has at least twice the population of South London. There are nearly 1,500 miles of street sewers, and 82 miles of main intercepting sewers. The latter were constructed between 1859 and 1865, for the most part, at a total cost of more than four millions sterling, by the Metropolitan Board of Works. Their chief engineer, Sir Joseph Bazalgette, by whom this great public work was designed and superintended, gave a precise account of it in a paper he read, in 1865, to the Institution of Civil Engineers. But we can only here mention some leading features of the system.

On the north side of the river three main lines of sewer—the High Level, the Middle Level, and the Low Level—proceeding, though not in a direct course, or parallel to each other, generally from west to east, converge and unite at Abbey Mills, on a creek in the marshes of the river Lea, where their aggregate contents flow by the Northern Outfall sewer to Barking Creek, thereby entering the Thames about twelve miles below London Bridge. The discharge into the river takes place only at high tide, so as to be carried down by the ebb. It goes down nearly twelve miles with the ebb tide, and no part of it returns with the flood tide beyond one mile above the point of discharge. The outfall on the south side of the Thames is at Crossness, in the Erith Marshes, somewhat lower down the river; so that none of the London sewage comes back to London.

The High Level Sewer, in Middlesex, is seven miles long, draining an area of ten square miles, including Hampstead, Highgate, Holloway, Hackney, and other northern suburbs. The Middle Level Sewer has a length of eleven and a half miles, including the branch from Piccadilly, crossing Leicester Square and Lincoln's-Inn-Fields to Gray's-Inn-Road; and the area which it drains, seventeen and a half square miles, comprises some of the most populous quarters of London. It begins at Kensal Green, and passes on from Notting Hill, along Oxford street, through Clerkenwell, Shoreditch, and Bethnal Green, to a junction with the High Level at Bow. The size or caliber of these main sewers gradually increases, from 4 ft. or 4 ft. 6 in. diameter, to 9 ft. 6 in. by 12 ft. at the outlet; they are of circular shape, and of stout brickwork, which becomes massive toward the end. The Middle Level sewer is carried over the Underground Railway, in one place by a wrought iron aqueduct of 150 ft. span. The Low Level Sewer, beginning at Pimlico, goes along the Thames Embankment, and from the City, at Tower Hill, along Commercial Road to Limehouse, and thence to Bow. Its contents are pumped up by the engines at Abbey Mills, a height of thirty-six feet, to the level of the two other main sewers at their discharge into the Northern Outfall; but these find their outlet by gravitation. The Low Level, which was the last main sewer completed, is eight or nine miles long, with four miles of branches, and drains eleven square miles. There is also the western division, with branch sewers for Chiswick, Fulham, and Acton, and their neighborhood. The Outfall Sewer, from Bow to Barking Creek, the pumping station at Abbey Mills, and the reservoir at Barking, are engineering works of great magnitude. The use of the reservoir is that the final discharge into the river may be regulated, to be allowed only at the proper hour, according to the state of the tide. This reservoir, which is covered, has an area of nine and a half acres, with nearly seventeen feet depth.

The main drainage of South London is formed on a similar plan, by intercepting sewers at different levels, uniting at Deptford Creek, whence their streams flow eastward in one outfall sewer, through Greenwich and Woolwich, to the Kentish bank of the Thames at Crossness. The main High Level Sewer begins at Clapham, and there is a branch sewer from Dulwich; these meet at New Cross, draining about twenty square miles. Their excess of storm rainfall waters is poured into Deptford Creek. This, we believe, is a great fault in the system, as Deptford Creek has enough to do, after heavy rains, with its natural duty of carrying off the swollen streams of the Ravensbourne and Quaggy, from Lewisham and Lee; those unfortunate suburbs are hereby victimized, and suffer terribly from occasional floods. The sewage of the High Level is, at Deptford, separated from the surplus water, and is conveyed by four iron pipes across the creek, to the Outfall Sewer, and on to Crossness. The Low Level Sewer drains Putney, Battersea, Lambeth, Southwark, Bermondsey, Rotherhithe, and Deptford, which mostly lie below the high tide level of the Thames, but are now rendered perfectly dry, in spite of their porous gravel soil. There is a pumping station at Deptford, by which, as at Abbey Mills, the contents of the Low Level are raised to the Outfall Sewer. The Outfall Sewer, from Deptford to Crossness, is nearly eight miles long, has 11 ft. 6 in. diameter, and lies 16 ft. below the surface of the ground, with a tunnel under Woolwich. At Crossness there is a reservoir, six acres and a half in area, like the Barking Reservoir, with powerful engines to pump and discharge the sewage into the Thames at high tide.

It must be acknowledged that these grand works have proved most effective in punctually removing from the metropolis, day by day, the noxious refuse of dwellings inhabited by above three millions of people. Many Londoners have a disagreeable recollection of the state of this huge city, and of its noble river above the bridges, even so far up as Chelsea or Hammersmith, twenty-five years ago. The health of those living on the south side of the Strand or Fleet street was positively endangered, and it was perilous to travel by the steamboats in sultry weather. Now, thanks to the Metropolitan Board of Works, the City and the West Central District are quite as salubrious as any of the suburbs. We believe that no feat of sanitary engineering has been accomplished in any age or country which can for a moment be compared with this achievement. If the New Zealander who shall visit London and "sketch the ruins of St. Paul's," as Macaulay fancied, in A. D. 2500, or thereabouts, will explore the remains of our Main Drainage System beneath the surface of the desolate streets, he will find something not less worthy to be admired than all that is left of Ancient Rome.—*Illustrated London News.*



UNDERGROUND LONDON—A PENSTOCK CHAMBER.

NICKEL AT THE EXHIBITION OF APPLIED SCIENCE, PARIS.

THE Jury for Class 34, "Matériel and Working of Mines and Metallurgy," lately made their official inspection of the collective exhibition organized by the Société Française Anonyme pour le traitement des minerais de Nickel, Cobalt, Cuivre, etc.; and the information afforded them has been obligingly communicated by the *administrateur délégué* of the company. The main stand contains specimens of the metal and its combinations in various stages of manufacture, from the ore to the finished article. Upwards of forty exhibitors take part in this interesting collection, the object of which is to show the advantage of employing in industry the alloys of nickel, in preference to brass or copper nickelized, and also the various applications of this new and beautiful metal.

The great impetus to the nickel trade was given by the discovery of important deposits of ore in the serpentine rocks of New Caledonia, the French penal settlement. The Australian geologist, Mr. W. B. Clark, and Professors Dana and Liversedge, were associated with M. Jules Garnier in the discovery; but they unanimously conceded to him the merit of priority by giving the name of *Garnierite* to the fine green mineral, which possesses the great advantage of containing none of those impurities which formed the great difficulty in previously treating this metal. M. Garnier considers this mineral to be contemporary with the magnesian rocks which form the backbone of New Caledonia, and to have been deposited in the numerous clefts of the serpentines, where it is found in the purest state and in

the largest quantities. Garnierite, a double hydro-silicate of nickel and magnesia, is free from sulphur, arsenic, antimony, and cobalt, as the following analysis* will show:

		Oxygen.	Ratios.
Silica	41	22	2
Protoxide of nickel	19	4·07	—
Magnesia	16·4	6·56	1
Alumina	0·6	0·28	—
Lime	trace	—	—
Water	20	18	4
Gangue	3	—	—
	100		

It is, however, almost always found in connection with the oxides and chromate of iron. The mineralogical formula is

$$(MgNi)\ Si + n\ H;$$

and a large block from the mines of Mr. J. Higginson, Numœa, New Caledonia, at once attracts attention to the show case.

Nickel ore had previously been treated by a long and complicated series of operations embracing both the wet and dry methods; but as no sulphur, arsenic, or antimony, and only infinitesimal quantities of iron and cobalt, have to be extracted from garnierite, two dry operations are sufficient. M. Garnier, who is connected with the company, has devoted the greater portion of the last four years to perfecting the process of extraction, and it is mainly due to his exertions, seconded by the skillful engineers under him, that nickel may now be obtained at a moderate price. By a simple operation, the ore, containing from 10 to 15 per cent. of metal, is transformed into a matt, or regulus, with from 40 to 75 per cent. of metallic nickel. This is effected by a roasting, or preliminary fusion, in blast-furnaces erected near the mines by Messrs. J. Higginson & Co., who have contracted to supply the French company with as much of the raw material as they may require. The matt, specimens of which are exhibited, is shipped by the French company to their works at Septêmes, near Marseilles. Here it is refined in special furnaces, and run into ingots perfectly free from sulphur, containing 99½ per cent. of pure nickel, ¼ per cent. being utilizable metallic substances, and the remaining ¼ per cent. waste. Besides ingots, portions of which have been polished, *grenaille*, or granules, of nickel are shown both varieties being used for forming the various alloys.

No small amount of prejudice exists against nickel among those who only know it in the state of electro-deposit; and this is not surprising, for not only does the thin coating of nickel soon wear off with cleaning, and expose the metal beneath, but even, in the case of iron and steel, nickel-plating affords no thorough safeguard against the oxidizing influences of the atmosphere. Although the French company produce and supply anodes of nickel for restoring to the galvanic bath the metal taken up by electro deposit, and also salts, in the form of simple sulphate of nickel and double sulphate of nickel and ammonia, for forming the bath, they are endeavoring as far as possible, to supersede this use of the metal by their various alloys. They contend that an alloy containing 20 per cent. of pure nickel is not liable to oxidation, and may be wrought with the same plant and by the same processes as brass and copper, while the finished articles are 20 per cent. stronger, and cost only a trifle more, than if made of brass and nickelized. The absence of oxidization saves much labor in cleaning, as the articles remain bright, and only require occasional washing, but no special cleaning like brass. By the side of white nickel bronze castings just as they have left the moulds, the show case contains a great variety of finished specimens formed by casting, rolling, or drawing, while others are *repoussé*, turned or engraved. All present that pure tint so much prized in nickel; and it is a satisfaction to know that they are composed of the same substance all through, and will not turn color on being exposed to the air, nor show red or yellow edges when worn with cleaning. Among the objects exhibited may be especially mentioned railway-carriage door-handles and hand-rails, door-handles for the New Opera, hinges, part of machines, taps and cocks, a large bowl beaten out of the solid casting, locks, name-plates, hooks and chains, buckles, lamps and reflectors, mathematical and optical instruments, medals and coins, statuettes and other works of art, for which it is admirably suited on account of its silver-like appearance. In fact, the collection is as varied as possible, in order to show what has actually been accomplished in the various branches of industrial art. The nickel is not worked up in a pure state, as it is found too brittle; but, besides the castings a *maillechort*, or German silver, is made, which differs from what has hitherto been known as German silver, in being of a white instead of a yellow tint. Among the sub-exhibitors may be mentioned MM. Rivain et Bezault, F. A. Lange, Gaspard et Belle, Lebrégeal, Sékutowicz et Huber, Quinier, Horstmann, Faucoult, Gruhier et Tranchard, Pinédo, and Chertier, besides the Silverine Company for spoons and forks.

By no means the least interesting exhibits are the articles made of *Acier Larocque*, or nickel steel, contributed by MM. Rullier, Mauget et Cie., consisting of an anvil and set; sledge, fitters' and coppersmiths' hammers; hatchets and other edge tools; a yacht anchor and vessel fittings; and also some drawn tubes. This combination is the result of experiments by M. Larocque, who found that a very small amount of nickel added to steel increases its strength, and causes edge tools made of the mixture to stand better than if of steel alone. This quality of great strength, combined with the cleanliness and freedom from oxidation imparted by the nickel, admirably fits nickel steel for the manufacture of surgical instruments, specimens of which are exhibited.

Besides the collective exhibition, the various products of the Compagnie Française may be seen worked up in the collections of individual exhibitors. In the pavilion of the President of the Republic is a suspension or hanging lamp, all the parts of which, whether cast, rolled, or stamped out, including the tubes and wire composing the chains, are of white nickel bronze. One specimen in the trophy of bells near the east entrance is composed of the same alloy, and it is said that the exhibitor, M. Crouzet Hildebrand—time honored name in bell founding—is so pleased with the result that he intends hereafter to employ it exclusively. Some beautiful furniture, including a chair and work-table for the future Queen of Spain, is shown by M. Giraudon; the framework is covered with the polished skin of a Chinese shark, inlaid with nickel, and the mouldings with a fine sheet of nickel bronze, the two harmonizing admirably and producing a highly artistic effect. Nickel bronze also enters into the composition of the lockwork of MM. Vaillant Fontaine et Quintart, the metal fittings of M. Gits, the saddlery of the Maison Million, and the mirror frames of M. Carpentier. In fine, if the Exhibition of 1878, at which the gold medal was awarded for this metal, showed that an important trade had been started in the metallurgy of nickel, that of 1879 shows the practical application of its products to the most important branches of industry.

The company do not sell various alloys ready made, the content of nickel in which cannot well be checked; but they supply either their pure nickel or an alloy containing half nickel and half copper, which facilitates the somewhat new process of fusion. In order to facilitate the introduction of their nickel alloys into foreign countries, however, and insure purity, they undertake to inspect the casting of the ingots at the works of the most skillful French founders, and to guarantee the purity of the ingots.

* Note sur un nouveau minéral de Nickel (Garnierite), par M. Gillet—Paris, ingénieur civil des mines, communication faite à la Société des Sciences Industrielles de Lyon.

ACTION OF LIME ON SILICA IN MORTAR.

By W. B. ROBERTS, M.S.A.

HAVING found in the recent analysis of some specimens of old mortar from the walls of a building erected about two hundred years ago, considerable traces of hydrated silica, it occurred to me that possibly the hardening or setting of mortar might be due to some chemical action occurring between the lime and the silica when these ingredients were mixed, whereby some proportion of the silica was caused to assume the gelatinous form; that this being then incorporated by the usual mixing process, subsequently solidified, binding the whole bulk with a hard network of silica. To test this, I obtained two good specimens, one from the exterior, and one from the center of a wall which was two feet thick, for the purpose of making a careful analysis of each. In order to compare the results with those of some experiments presently to be described, I also examined a sample of mortar from a building of comparatively recent date.

Subjected to the mechanical test of a gradually increasing pressure, the two older samples proved about equal in hardness, while both of them were harder than the third. The samples taken for analysis were quite free from brick, and few of the grains of sand were of greater weight than about 1 grm.

The specimens were crushed fine in a steel mortar, and 200 grms. of each treated for twelve hours with sulphuric acid (sp. gr. 1·65); the temperature was then gradually raised until the excess of acid was completely expelled; after cooling the residue was boiled up repeatedly with water: the insoluble residue gave the total silica—conveniently referred to as silica, silica free, and sand.

To find amount of soluble silica, the insoluble residue was boiled with a saturated solution of sodium carbonate for a considerable time; the liquid, after filtration, was treated with hydrochloric acid and evaporated to dryness in the usual way, and gave the amount of free and combined soluble silica in the mortar.* Then, to ascertain how much, if any, free hydrated silica, *i.e.*, silica which was or had been gelatinized, existed in the mortars, 200 grms. of each were treated with saturated solution of sodium carbonate exactly in the manner just described for separating the soluble silica from the sand. The percentage of previously gelatinized silica was confirmed by treatment with pure hydrofluoric acid. The other constituents were estimated by the ordinary methods. The following were the results obtained:

	I. From Exterior of old Wall.	II. Interior of old Wall.	III. More recent Mortar. Exterior.
Sand	67·12	67·19	65·54
Combined silica	1·12	0·93	0·18
Free hydrated silica	0·68	0·40	0·09
	68·92	68·52	65·81
Calcium carbonate	25·05	28·04	31·84
Magnesium carbonate	0·68	0·60	0·09
Sodium carbonate	0·90	1·41	trace
Lime originally as silicate	1·05	—	—
Soda	0·41	—	—
Calcium sulphate	0·49	0·43	0·19
Sodium chloride	0·17	0·14	0·08
Oxide of iron, alumina	0·02	0·02	0·01
Water, hygroscopic	2·09	1·02	1·78
	99·78	100·18	99·80
Carbonic anhydride	11·78	13·18	15·033

To find as far as possible whether the original lime had contained any calcium silicate—this being, as is well known, produced sometimes in comparatively large quantities during the burning of different limestones—as much of the lime as could be picked out free from sand by the aid of a lens was tested for free or combined soluble silica in the same way as the mortar. The results were:

	I.	II.	III.
Soluble silica per cent.	0·17	0·20	0·11

Further, to test whether, in a comparatively short time, the sand would be attacked by freshly slaked lime, 300 grms. of fine sharp sand, free from soluble silica, were placed in each of three bottles under the following conditions for six months, after which time analysis gave the results stated below:

	Soluble Silica Per cent.
I. Mixed with 150 grms. pure lime, and sufficient water to make a thick paste, and prevented from absorbing CO_2	0·09
II. Same as I., but with the addition of 2 grms. of mixed carbonate of soda and potash	0·17
III. Same as II., with occasional slow current of CO_2, besides constant access of atmospheric air,	0·08

From the general results of the above analysis and experiments, I conclude that the accepted theory of the hardening of mortar, namely, that it is due to the absorption of carbonic acid is unshaken.

In the cases of the experiments I. and II. the conditions have been very favorable for the action of the lime upon the silica, but its effects are manifestly too small to materially influence the hardness of the resulting mortars. However, samples I. and II. were harder than III., although I. contained much less CO_2 than III. My general conclusion may be summarized as follows:

(1.) Practically no gelatinization of silica occurs in the manufacture of mortar.

(2.) That under the ordinary conditions of access of atmospheric air the lime in mortars becomes gradually dehydrated, absorbs carbonic acid, and forms neutral carbonate.

(3.) That the absorption of carbonic acid is very slow.

(4.) A slight action takes place between the lime and the silica, though this appears to be too small to determine its nature.

(5.) That, although even the small proportion of dry silicates slightly increases the hardness of a mortar, the ordinarily sufficient hardness of mortar is obtained by simple dehydration and carbonation.

These conclusions appear to be confirmed by the fact that lime already containing a small proportion of carbonate is preferred to pure lime for making mortar.—*Chemical News.*

* Thorpe, "Quantitative Analysis," p. 185.

VOLATILITY OF PLATINUM IN CHLORINE GAS AT HIGH TEMPERATURES.*

By SEELHEIM, of Utrecht.

SOME years ago the author made the curious observation that when platinum foil is kept at a red heat in dry chlorine gas, the metal gradually volatilizes, and in a colder part of tube gets re-deposited as a sublimate, consisting of measurable *crystals* of the regular system. The crystalline nature of the sublimate proves that the metal must have traveled through the tube as a *vapor*. In order, however, to make quite sure of this important result, the author, quite lately, repeated the experiment in a modified form, consisting in this, that he heated a quantity of platinous chloride in a porcelain flask to bright redness. The flask was allowed to cool and then cautiously broken up, when the metallic platinum due from the chloride was found, not at the bottom of the flask, but somewhere higher up at the sides, in the form of a crystalline sublimate. This, the author says, confirms what was observed some some time ago by Troost and Hautefeuille, who found that platinous chloride, when heated to 1,400° C. in a porcelain flask, and allowed to cool, suddenly gives a deposit of $PtCl_2$, while when cooled down gradually it yields only Cl_2 and metallic platinum.

The volatilization of the platinum must be owing to a chemical cause. We must assume that the metal, when heated in chlorine gas, passes, at least, temporarily, into a volatile chloride, which, *at lower temperatures*, breaks up again into chlorine gas and metallic platinum. If this chloride is $PtCl_2$, and $PtCl_2=1$ molecule, its vapor should occupy the same volume as the "Cl_2" contained in it, and consequently Victor Meyer's experiments proved, as before, that "Cl_2" at high temperatures dissociates into two or more molecules. But it is more natural to assume that the $PtCl_2$ vapor has only a transitory existence, being continually formed and re-decomposed into Pt vapor and chlorine. At any rate, Victor Meyer's results do not prove that chlorine gas (at 1,500° or so) undergoes dissociation, because what he operated upon was not pure chlorine but chlorine contaminated with volatilized platinum.

So far Seelheim. In my opinion the most natural interpretation of Seelheim's *and* Meyer's results is to assume that 2 ($Pt+Cl_2$), produced by the decomposition at a *dull* red heat of $2PtCl_2$ at higher temperatures, *associate* into $2PtCl+Cl_2=6$ vols. (*i.e.*, 6 times the volume of $\frac{1}{2}H_2$)=$\frac{3}{2}$ times the volume the $2Cl_2$ present at the lower temperature. Or else we may assume that the atomic weight of platinum is pt.$=\frac{1}{2}$Pt, and that, what on starting was $2pt_2Cl_2$ (solid), at higher temperatures got transmitted thus:

	$2pt_2Cl_2$	$= pt_4+2Cl_2$	$= 2ptCl+pt_2Cl_2.$
	Ord. temp.	500°	1,500°
Vol. =	0	0+4	4+2
or—	0	4	6

Meyer's discovery, then, appears to be a mistake, but it is one of those mistakes that could only have been committed by a great experimenter like him.—*W. D.*

Anderson's College, Glasgow, Nov., 1879.

PREPARATION OF PERFECTLY PURE HYPOPHOSPHITE OF SODA.†

By M. BOYMOND.

IT has long been known that the preparation of hypophosphite of soda by the action of phosphorus on a solution of soda is not a practical process. This finds a ready explanation in the property possessed by the hypophosphites of oxidizing rapidly in alkaline solutions in proportion as the base is energetic and the solutions concentrated. It consequently happens that in heating phosphorus in a strong solution of potash or soda, much phosphite is formed, and in boiling hypophosphites in such solutions they are converted, with disengagement of hydrogen, into phosphites and phosphates. Besides the formation of a considerable quantity of phosphite, this process presents the inconvenience that the phosphite and phosphate formed, as well as the alkali in excess, are dissolved, and are very difficult to eliminate.

As to the preparation of the hypophosphites by means of a milk of lime, although that base presents important advantages over soda—as the quantities of phosphite and phosphate formed are less considerable and the elimination of these salts and the lime in excess is more easy—this process does not yield a perfectly pure product, the proportion of phosphite and phosphate present amount sometimes to as much as five per cent. Hypophosphite of soda prepared with such a salt of lime could not be pure. Besides, even when the hypophosphite of lime is perfectly pure, the evaporation in a water-bath of an alcoholic solution of pure sodic hypophosphite is sufficient to give rise to an appreciable quantity of phosphite.

The author has obtained this salt entirely pure by employing, in the place of hypophosphite of lime, a clear solution of hypophosphite of baryta, in the following manner:

25 grammes of commercial hypophosphite of soda, containing phosphite, and one gramme of hypophosphite of baryta (sufficient to precipitate all the phosphorous and phosphoric acid contaminating the product) were mixed and water added so that the volume of the whole solution did not exceed 50 c.c. Some time afterward, without filtration, nearly 200 c.c. of absolute alcohol were added, the mixture was allowed to stand, and then filtered. In this way all the phosphoric acid was precipitated, as well as nearly all the excess of baryta in the state of hypophosphite. To the clear filtered liquid was added, in small quantities, sufficient solution of sulphate of soda to precipitate the baryta still dissolved; then about 100 c.c. of absolute alcohol was added and the liquid allowed to stand. The clear liquid obtained by filtration and decantation was afterwards mixed in a

* A condensed translation of an article in the last number of the *Berichte der Deutscher Chemischen Gesellschaft.* Communicated by Prof. Dittmar.—*Chemical News.*

† *Répertoire de Pharmacie.*

larger vessel with about 500 c.c. of absolute alcohol, and as much absolute ether as was required to agitate the mixture strongly, when all the hypophosphite separated. The salt was collected and deprived of the last traces of alcohol and ether by passing over it a current of dry air.

The ethereo-alcoholic liquid, after the separation of the salt, was completely neutral. The hypophosphite, crystallized in small needles, dissolved perfectly in water and in alcohol, and the solution was not rendered turbid by the addition of baryta or sulphate of soda. Once only it contained a trace of sulphuric acid, consequent upon the employment of a slight excess of sulphate of soda.

DECOMPOSITION OF CHLORINE.

MR. FRED'K BARKAS, of the Zurich Polytechnikum, writes as follows:

"A most important chemical discovery has just been made by Herren Victor and Carl Meyer, of the Polytechnikum, Zurich. Herr Victor Meyer had been making a number of experiments to determine the vapor densities of some organic compounds whose constituents were doubtful. Having invented a new and simple apparatus for the purpose, in order to determine its accuracy he made several experiments to test the vapor density of the commoner elements—oxygen, etc.—at temperatures from 100° C. (boiling water) to 1,567° C. (heat given by a gas furnace). At length he tried chlorine, which was obtained by heating pure dry bichloride of platinum, but the results were not in accordance with theory. When the gas was heated at temperatures under and up to 620° C. it gave a density of 2·46, while theory gives 2·45. This was very good; but at 808° C. the density was only 2·20. At 1,028° C. it gave 1·87, while at from 1,242° C. to 1,567° C. the density remained nearly constant at 1·64 average. From this it was to be inferred that two molecules of chlorine at temperatures above 1,200° C. break up into the three molecules.

Next came the question, Does this arise from an alteration of the molecular constitution of chlorine, or from an actual decomposition into some new gases; in other words, is chlorine an element? Thereupon the expanded chlorine gas was slowly caused to stream into a fluid that absorbs chlorine. Potassa, iodide of potassium, and mercury were all used for the purpose, and with the same result—a gas accumulated in the measuring tube that was not chlorine, but oxygen. Chlorine was thereby proved to be not an element but an oxide of some new element. A number of careful investigations were then made to be sure that the chlorine used was absolutely pure and dry, but with the same result. The new element, hypothetically called *Murium*, has not yet been isolated, but the learned professors are carrying out the important investigation with all diligence, so that doubtless within the course of a few weeks we shall hear more of the new element, *Murium*. That chlorine is an oxygen compound is not altogether a new idea. Sir Humphry Davy, after his celebrated discoveries of the compound nature of soda and potassa, surmised that chlorine, iodine, and bromine were likewise oxygen compounds.

SPECIFIC HEATS AND MELTING POINTS OF VARIOUS REFRACTORY METALS.

By J. VIOLLE.

THE specific heat of iridium, like that of platinum, increases regularly with the temperature. The mean specific heat of gold varies little up to 600°, and then increases sensibly on approaching the melting point. The melting points given are: Silver, 954°; gold, 1,035°; copper, 1,054°; palladium, 1,500°; platinum, 1,775°; iridium, 1,950°.

CELLULOSE.

By M. FRANCHIMONT.

THE author adds to a mixture of 1 part of cellulose and 4 parts of acetic anhydride a little sulphuric acid, when a brisk reaction is set up and the cellulose disappears, whilst the liquid becomes colored. The whole is then thrown into a large excess of cold water, which gives a copious white precipitate. The precipitate is washed in cold water and dried in the air, and is next introduced into alcohol, which dissolves a part and turns slightly yellow. It is filtered, washed in alcohol, and the residue dissolved in boiling alcohol. The solution deposits acicular crystals, composed of $C_{46}H_{54}O_{27}$. It seems to be an eleven times acetylated derivative of a triglucose, $C_{18}H_{32}O_{16}$.

CHLORIDE OF LIME BATTERY.

By A. NIAUDET.

THE battery has for its positive electrode a plate of zinc, and for its negative electrode a plate of coke surrounded with fragments of coke. The zinc is placed in a solution of common salt; the coke is surrounded with chloride of lime, in a vessel of biscuit ware or of parchment paper.

NON-POISONOUS VEGETABLE FLY PAPER AND RAT EXTERMINATOR.—Reisenbichler calls attention to the fact that the poisonous preparations employed for the destruction of vermin could easily be replaced in the market by others equally effective and altogether free from danger. He suggests for the destruction of flies porous paper spread with a mixture of sirup and pulverized black pepper, the latter being a deadly poison for flies. When used it requires simply to be moistened and spread on a plate. For rats, he recommends squills, cut into cubes, then thoroughly dried and pulverized, and made into brittle, porous cakes, from 0·2 to 0·4 of an inch thick, with common paste, with a little starch added. When used they need simply be saturated with hot grease.

TEST FOR COLORING MATTER IN RED WINE.—Sulzer has found that on mixing an equal volume of nitric acid with a sample of the wine to be tested, the color if natural will remain unchanged for at least an hour, whilst if artificial it will be discharged, or changed within a minute. The reaction has been found to take place with the coloring matter of whortleberries, mulberries, mallows, logwood, Brazilwood, and *Phytolacca decandra*, as well as with carminic acid and fuchsine.

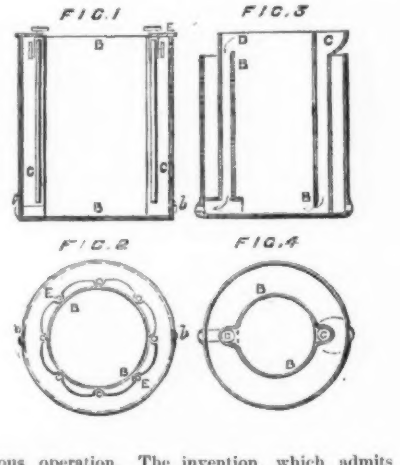
MELTING ASPHALTUM.—The burning of the film adhering to the sides of the kettle in melting asphaltum and the consequent smoking, which no amount of stirring can prevent, may be avoided, according to Reisenbichler, by melting on a bath of concentrated solution of chloride of calcium in water. As this boils at about 358°, a uniform high temperature may be obtained.

THE AFRICAN CABLE.

THE great African cable is the longest in the world, it being nearly 4,000 miles from Aden to Natal; but for the convenience of working, as well as to facilitate any necessary repairs, it has been sunk in four sections. The first, for a distance of 350 miles—from Durban, in Natal, to Lorenzo Marquez, at Delagoa Bay—has been laid, as also has the second section, from the bay to Mozambique, a distance of 1,000 miles; and very recently the line from Mozambique to Zanzibar was finished. Thus the fullest details of all that is passing in South Africa will be forwarded to that station and carried on over the last and longest section to Aden, where it will have the choice of four routes to England. This last link, of 2,000 miles in length, will not be completely in working order till the middle of December, but in the meantime, we believe, it is the intention of the government to place one or more fast dispatch boats at Zanzibar to forward all important intelligence; and if this is done we ought to have frequent dispatches only three or four days old. Except the last section, the line is all laid in 500 fathoms of water and in sight of the high lands of Africa. The minimum rate at which the cable has been contracted to work is fourteen words a minute. But the tendency of all cables when submerged is to improve so rapidly, that at a rate of at least eighteen words a minute, or about a thousand words an hour, is likely to be soon attained. This would give nearly two-thirds of a newspaper column per hour, or sixteen newspaper columns in the twenty-four, as, of course, it would work day and night. With the completion of this link the last of the great imperial dependencies will be placed in direct communication with England, and the experience of the working of all previous lines shows the almost inestimable value, both to colonies and crown, of such a swift and secret means of the fullest and most confidential intercourse. The government, of course, have a secret cipher of their own, which is so arranged that messages can be sent with less than one-quarter of the signs, and, therefore, in less than one-quarter of the time required for the ordinary signals. By-and-by the warlike news of the cable will settle down into commercial items—exchanges, prices of wool, ivory, skins, ostrich feathers, and diamonds, and all that goes to make a submarine cable as valuable in peace as it is useful in war. But its first news of the capture of Cetewayo is certainly likely to be its best for some time to come.

A NICKEL BATTERY.

AN improvement in galvanic batteries, recently patented by T. Slater, London, consists in the employment of nickel in such a manner that the salts of that metal produced by the action of the battery are of commercial value, and in the arrangement of the elements in such a manner that the cells are of the "perfluent" type, by which the battery is kept in



continuous operation. The invention, which admits of many modifications, may be thus described:

With a cell of two metals in two liquids the patentee prefers using a porous diaphragm, in which he places a cylindrical plate of nickel which may be crimped, grooved, furrowed, or corrugated; or nickel in grains in those cases where the diaphragm is round or cylindrical; and where the same is square or oblong, by preference flat plates. Surrounding the nickel cell, he places any suitable or desired number, according to the size of the vessels, of narrow prisms or plates of carbon placed not more than a quarter of an inch apart in order to obtain the best effect, though any less number or a single prism, or plate, or cylinder will work, but not so efficiently.

When a series of prisms or plates surround the nickel cell, and to insure good connection with each prism or plate, it is better to have a clamp of metal with a projecting part, pin, or screw at the top of each clamp, and a ring of metal with holes corresponding to the number of prisms or plate clamps, made to fit thereon, and with suitable heads to the clamp, the whole may be firmly and securely tightened and easily removed for cleaning when necessary to do so. This ring or part will be varied in shape and dimensions, according to the form and size of the cell in or with which it is to be used. The carbons may be used in a metal ring cast or otherwise suitably formed to hold them, but the electrolyte very soon reaches the metal, oxidizes the same, and the resistance offered to the current is considerable. A compound cell arranged as follows may also be used:

First a cylindrical or other suitably shaped vessel or outer receptacle, and two porous and concentric diaphragms, the outer being about half an inch larger in diameter than the middle cell. In the center diaphragm is placed the plate of nickel with its excitant, which may consist of diluted sulphuric, nitric, or hydrochloric acid in the proportion of about one part by measure to eight parts of water, or any stronger or weaker proportion, as may be deemed expedient for the work to be done. The larger diaphragms are filled in with a solution of sesqui-carbonate of ammonia, and in the outer vessel is placed a solution of sulphate of nickel, or the double sulphate of nickel and ammonia with the prisms or plates of carbon, or such metal as will receive the deposit of the metallic nickel as it becomes precipitated from its solution, in the same way as the well-known Daniell battery precipitates the copper from its sulphate.

In order that the battery may be kept in continuous operation, and the strength of the excitant more easily be kept up, the patentee arranges it in the following manner: He places the battery on a stand or support, and over it a vessel or reservoir (to contain the exciting fluid), from which the air is exhausted by a pump or other convenient means when filling the same; here is an adjustable outlet, and proper means for leading the excitant to the cells. From the vessel in which the cells are placed is also an outlet leading into a vessel placed beneath the stand into which the excitant may flow from the battery. From this vessel a pipe of India rubber leads the fluid to pass from the lower vessel or receiver to the upper one so as to keep up the supply; and in order that the partially exhausted excitant may have its strength restored before returning to and passing from the upper vessel to the battery, the required amount of acid is added to the contents of the lower vessel previous to pumping it to the upper one, and thus by properly adjusting the outlets the battery is kept in continuous operation more readily than by any other method.

Fig 1 represents in sectional elevation, and Fig. 2 in plan, an arrangement of the improved nickel battery used with a single excitant, though if desired two may be employed; B is the porous diaphragm; C, carbons or nickel, with clamps and screws for holding the same, and E, ring for supporting them; A is the outlet from the inner cell; and B, the outlet from the outer cell; but either of the arrangements for the "perfluent" battery may be applied to this if desired. In Fig. 2 the outer vessel is indicated by the dotted lines, and the clamps are not shown supported by the ring, only the holes in which they fit. Fig. 3 shows in sectional elevation, and Fig. 4 in plan, an arrangement of the improved nickel battery, in which two excitants are to be used, although, if desired, it may be used with one only, designed to facilitate the emptying of the inner cell without removal, and so as to allow of its ready employment as a "perfluent" or constant battery, the outer vessel and inner or porous diaphragm being made in one piece and the outer vessel "indurated," so as to be water tight, by the use of silicates or other suitable means; B is the inner or porous diaphragm; C, inlet passage; D, overflow passage and outlet from inner cell, both being shown open. The patentee has devised several modifications of cell and battery arrangements, but the above will sufficiently indicate the principle, the chief feature of the invention being the employment of nickel in the manner indicated.

ANALOGY BETWEEN THE CONDUCTIVITY FOR HEAT AND THE INDUCTION BALANCE EFFECT OF COPPER-TIN ALLOYS.

THIS was a paper recently read before the Physical Society, London, by W. Chandler Roberts, F.R.S.

Mr. Roberts traced a remarkable resemblance between a curve representing the induction balance effect of the copper-tin alloys published by him in June last, and the curve of Calvert and Johnston for the conductivity of heat, and, on the other hand, he showed that the induction curve does not agree with Matthiessen's curve for the electric conductivity of the same alloys. The author showed that the two alloys which occupy critical points of the curve, $SnCu_3$ and $SnCu_4$, are of much interest. Possibly both are chemical combinations, and the wide difference in the position they occupy probably marks a difference of allotropic state. For the solution of such questions, however, Mr. Roberts considered that we might look with confidence to Prof. Hughes' beautiful instrument, which, he hopes, will also enable us to determine whether the relation between conductivity for heat and electricity is really as exact as it has hitherto been supposed to be.

As supplementary to this subject, Dr. O. J. Lodge stated that he had compared the conductivity of six bars of the tin-copper alloys, measured by the balance and by the Wheatstone bridge, and found them to agree very closely on the whole. The bridge results confirmed the resemblance traced by Mr. Roberts still more than the induction balance results.

Prof. Hughes expressed his opinion that existing tables of metal conductivity were erroneous. They disagreed among themselves, and the induction balance showed that it was impossible to get two pieces of the same metal exactly alike; hence the variation of specific conductivity results.

Prof. Ayrton stated that at a former meeting he had suggested that the electric inertia of the different specimens of metal tested might cause the difference between the results obtained by the Wheatstone bridge and the induction balance. Mathematical calculation had since led him to the conclusion that the inductive effect is not proportional to the resistance of the metal tested, but to a *power* or exponential of the resistance.

Prof. Hughes replied that as the inductive effect of the metal was destroyed by cutting it so as to interrupt the circuit in it, it was reasonable to suppose that the said effect was due to induced currents circulating in the metal, and therefore was proportional to the conductivity of the metal.

Capt. Armstrong exhibited a standard Daniell cell formed of porcelain vessel with a porous partition dividing it into two compartments. In one the zinc plate was immersed in a solution of sulphate of zinc; in the other the copper plate in a solution of sulphate of copper. To use the cell as a standard, it was only necessary to connect the two liquids by a cotton string moistened with water. This arrangement prevented mixing of the liquids, as the string could be withdrawn after use. The resistance was high, but it was a constant standard of electromotive force.

Prof. Guthrie mentioned that Prof. Pirani, of Melbourne, in a letter to him had signaled the fact that when a dilute acid was being electrolyzed, the positive electrode, if made of iron, became incandescent below the surface of the liquid. Prof. Guthrie had found this to be true not only for iron, but for other metals, and that it could hardly be due to oxidation, because it took place not only at the cathode or positive electrode, where oxygen was evolved, but also at the anode, where hydrogen was evolved. The incandescence appeared to him to be due rather to resistance. The author exhibited his experimental results, which he did not doubt had already been obtained by Prof. Pirani himself. The positive electrode when immersed in the electrolyte was seen to get red hot and to wabble about. As the liquid heated, the red glow became fainter. The negative electrode, on the other hand, emitted a bright light, accompanied by a sputtering noise. The light was tinged with the characteristic color of the flame of the metal of which it was composed; in the case of a copper electrode, for example, it was greenish. These effects were shown by Prof. Guthrie with iron, copper, and platinum electrodes, in dilute sulphuric and dilute nitric acid.

In reply to Prof. Adams, Prof. Guthrie said he had not yet examined the flame by the spectroscope; and in reply to

Prof. Foster, he stated that the battery power used was 50 Grove cells. He asked for suggestions as to the true cause of the phenomenon.

THE ILLUMINATION OF CAVITIES BY GEISSLER'S TUBES.

By HORATIO R. BIGELOW, M.D., Washington, D. C.

THE stratification of the electric light, by passing a discharge of the Ruhmkorff coil through glass tubes containing a highly rarefied vapor or gas, has been very satisfactorily investigated by Masson, Grove, Gassiot, Plücker, etc. The tubes made by Geissler, of Bonn, are filled with different gases or vapors, and exhausted so that the pressure does not exceed half a millimeter. At the ends of the tubes are two platinum wires soldered into the glass. The striæ given by hydrogen under half a millimeter of pressure are white in the bulbs and red in the capillary parts. The striæ in carbonic acid under a quarter millimeter of pressure are greenish. In nitrogen the light is orange-yellow. According to Ganot, "Plücker has found that the light in Geissler's tubes does not depend on the substance of the electrodes, but simply on the nature of the gas or vapor in the tube. He has found that the lights furnished by hydrogen, nitrogen, carbonic oxide, etc., give different spectra when they are decomposed by a prism. The discharge of the coil which passes through a highly rarefied gas would not pass through a perfect vacuum, and the presence of a ponderable substance is absolutely necessary for the passage of electricity. By the aid of a powerful magnet Plücker tried the action of magnetism on the electric discharge in a Geissler's tube, as Davy had done with the ordinary voltaic arc, and obtained many curious results. He found, where the discharge is perpendicular to the line of the poles, it is separated into two distinct parts, which can be referred to the different action exerted by the electro-magnet in the two extra currents produced in the discharge." It remained for De la Rive to prove, in a most ingenious manner, that magnets act on the light in Geissler's tubes in accordance with the laws with which they act on any other movable conductor. As the intensity of the light does not depend upon the number of elements used, it is best to use a discontinuous current with a single element. With the aid of a duck bill fenestrated speculum, wherein the blades are of the lightest possible construction, very gratifying results may be obtained in the illumination of the vagina. Two bulbs armed with platinum wires are soldered to a capillary tube; this tube is bent in the middle so that its branches may touch, and at its extremity is twisted upon itself. It is then filled with a rarefied gas, and when the discharge passes through, a very brilliant light appears at the twisted end of the tube. In its use there is no inconvenience to the physician and no discomfort to the patient. Abnormal conditions of the external os, and even those derangements which are due to intrauterine disorder, may be clearly made out. With a sufficiently long capillary tube, the entire cavity of the womb may be brilliantly illuminated.—*Medical Record.*

THE LATE PROFESSOR CLERK MAXWELL.

THE news of Professor Maxwell's death came with a sudden shock to many who are familiar with his name, for he was not an old man—he was in the prime of life, and great things were yet expected of him. Although it was not generally known, he had been ill for several weeks before he succumbed to his disease on November 5, at his residence in Scroope terrace, Cambridge. James Clerk-Maxwell was a Scotchman by birth, having been born at Edinburgh in 1831, a time when the northern metropolis, in virtue of its magnificent site and the cluster of famous men who dwelt there, earned for itself the proud title of the "Modern Athens." After being schooled at Edinburgh, a city still celebrated for its educational institutions, he was entered as an undergraduate of Trinity College, Cambridge, in 1850. Here he pursued his studies with so much success that at the end of four years he graduated as bachelor of arts and second wrangler. Mere mechanical expertness in writing, and sheer book-work, form so large an element in the tests for the Mathematical Tripos, that it frequently happens that the student of most original mathematical power is beaten in the competition by a far shallower but readier man. A notable instance of this occurred when Sir William Thomson lost the senior wranglership to Dr. Parkinson, who, in the estimation of the examiners, was a man of far less ability and promise than Sir William, but who has nevertheless achieved a wide reputation. The Smith prize, however, which is a kind of consolation stakes, offers an excellent chance for native mathematical ability to display itself, and turn the tables on the well drilled plodder. Hence it was that Sir William Thomson carried off the Smith prize from Parkinson, and Clerk-Maxwell was declared co-equal with Mr. E. J. Routh, the senior wrangler of the year.

In October, 1855, Maxwell was elected to a fellowship of his college, and in the following year he was appointed professor of Natural Philosophy in the Marischal College, Aberdeen. Here he remained until 1860, when he was called to King's College, London, as the professor of experimental physics, a post now occupied by Professor W. G. Adams.

Many of our readers are probably aware that the regulations for the Cambridge Mathematical Tripos were revised in 1868, and that the important subjects of heat, electricity, and magnetism were introduced for the first time. This step having been taken it became necessary to provide for the efficient teaching of the subjects in question, and accordingly, by a decree of the senate of the university, dated February 9, 1871, it was resolved to establish a professorship of experimental physics; the principal duty of the professor being to teach and illustrate by experiment the laws of heat, electricity, and magnetism, to apply himself to the advancement of the knowledge of these branches, and to promote their study in the university. Professor Clerk-Maxwell, who had given copious proof of his mathematical genius and general ability to fill this office, was unanimously elected to the new chair, and delivered his inaugural address on October 25, 1871. "For the last eight years," says a writer well qualified to express an opinion, "Professor Maxwell has labored assiduously, both in term and vacation, to carry out the objects of the professorship, and has succeeded in attracting an unusual number of earnest students, many of whom have highly distinguished themselves in the Mathematical Tripos." Through the munificence of the Duke of Devonshire, the professor's means of instruction were largely supplemented by the erection and equipment of the Cavendish Laboratory, which is one of the finest of its kind in the world. By a singular provision, the said professorship terminates by the death of Professor Maxwell, unless, as is highly probable, the university authorities shall decide to continue it.

Professor Maxwell's feats as a mathematician early procured him a fellowship of the Royal Society. In 1857 he took the Adams prize at Cambridge for an essay on the "Motions of Saturn's Rings," and, as if to prove his powers of experimental investigation, he also carried off the Hopkins prize, given for an original research. His original papers on mathematical and physical subjects are chiefly to be found in the Transactions of the Royal Society, the Transactions of the London Mathematical Society, and the Cambridge Philosophical Society, as well as the Cambridge and Dublin Mathematical Journal. His great work is the well-known "Treatise on Electricity," first published in 1873, in two volumes, by the Clarendon Press. Since then it has maintained its place at the head of electrical literature. Another less important work, equally admirable in its way, is "The Theory of Heat," which has passed through four editions; and more elementary, though of great value, is his little book entitled "Matter and Motion." This volume is introductory to the study of physical science, and much better than many pretentious works, does it "guide the current of thought along the channels of strict dynamical reasoning."

Professor Maxwell has on several occasions filled the office of examiner for the Mathematical Tripos. He has been president of the Cambridge Philosophical Society, and of the Physical Section of the British Association. He was an honorary fellow of Trinity College, Cambridge, a rare distinction, now shared by the Poet Laureate, the Astronomer Royal, and a few more eminent men.

As we can only judge of a man's powers with safety by having regard to his actual work, it would appear that Clerk-Maxwell was at his strongest as a mathematician, or rather as a mathematical physicist. He belonged to the school of Sir William Thomson, together with the late Macquorn Rankine, Dr. Joule, Professor Tait, and others. The principal labor of these physicists is to apply mathematical reasoning to experimental data, in order to arrive at general laws; and their favorite study is molecular physics. Maxwell was one of the most promising and honored of these molecularists. His device of the "sorting demon" will be remembered as long as the kinetic theory of gases will be studied. By his colleagues he was deemed a star of the first magnitude, yet to shine forth in full splendor; but alas! for these hopes, the star of the future has untimely faded into star mist. Much was expected from Clerk-Maxwell, which can never now be realized; and his premature death is not only a severe loss to the educational staff of his university, but to the molecular science of the world.

Professor Maxwell was a consummate writer. Whether we scan his large "Treatise on Electricity," his small book on "The Theory of Heat," his famous British Association discourse on "Molecules," or his "Rede" lecture on the "Telephone," delivered last year, we shall have to confess that his literary workmanship is exquisite. The arrangement is uniformly excellent, and the style is lucid, brief, and forcible, the perfection of purely scientific writing. Each of his short, clear paragraphs is complete in itself, but so fitted into the whole, that to detach it, or even a single sentence of it, would be to mar the entire text. Like a perfect crystal, no part of the writing can be spared without mutilation. Nor are these scientific efforts the only fruits of his active pen; for his rich fund of native humor was always overflowing, either in conversation or in mathematico-poetical squibs, or physio-comic parodies of admired stanzas. These effusions generally appeared in our contemporary, *Nature*, over the inscrutable signature, $\frac{d\,p}{d\,t}$, and some of them are extremely clever, as, for example, his "Electrical Valentine." Such literary trifles indicate the sprightly reaction of a fertile brain from its severer studies, and we may remark here, in passing, that the late Professor Rankine composed in his leisure moments some capital songs and verses, which are now published in a small volume by Messrs. Maclehose, of Glasgow. It is to be hoped that Professor Maxwell's lighter pieces will also be collected and given to the world in some cheap form.

One of the latest issues of Professor Maxwell's pen was a review of "Paradoxical Philosophy," the sequel to that remarkable work, the "Unseen Universe." In discussing the immemorial problem, What is the soul? the professor writes, "No new discoveries can make the argument against the personal existence of man after death any stronger than it has appeared to be ever since men began to die, and no language can express it more forcibly than the words of the Psalmist: 'His breath goeth forth, he returneth to his earth; in that very day his thoughts perish.' . . . Science has compelled us to admit that that which distinguishes a living body from a dead one is neither a material thing, nor that more refined entity, 'a form of energy.' There are methods, however, by which the application of energy may be directed without interfering with its amount. Is the soul like the engine-driver, who does not draw the train himself, but, by means of certain valves, directs the course of the steam so as to drive the engine forward or backward, or to stop it?" We quote these words, at the risk of being prolix, because there is a solemnity in the thought that the mind which thus asked itself these great riddle in vain, was so soon to solve it.—*Engineering.*

OPTICS.*

THE science of optics may be considered under two aspects—namely, that of light, and that of vision. It is the former of these two aspects that I purpose to introduce to your notice this evening, and to demonstrate to you the only proper mode by which darkened localities may be illuminated by means of reflected and refracted rays of light. In doing this I shall endeavor to confine my remarks, as far as possible, to the practical rather than to the theoretical view of the subject—the results that the study of theory has taught us to arrive at, rather than to trace the elimination of the truth of that theory by algebraic formulæ.

Theory, we are all of course aware, must be thoroughly well investigated before its truth can be demonstrated and reduced to actual practice, and it is as necessary for the manufacturer of plate glass that he should be acquainted with the theory of optics as it is that the engineer should be well grounded in the theory of engineering science. It would, however, occupy too much of your time, in a short and practical lecture like the present, to recapitulate the algebraic theory of optics, which would, probably, tend to decrease your interest in the subject that I hope I may be able to excite, by confining myself, as I purpose doing, to practice and subsequent illustration by experiment.

I must premise, then, at the outset, as a self-evident truth, that any ray of light passing from one point to another in the same medium will travel in a right line, provided only that no secondary influence be permitted to disturb its course.

Let us take, for example, the sun, as the principal source of light. So long as its rays travel toward the earth *in vacuo*, they do not deviate from the right line, but, on approaching within about forty-five miles of the surface of the earth, the disturbing element is reached in the form of atmospheric vapor, and which immediately interferes with the course taken by these direct rays, causing them slightly to deflect. This it will continue to do in exact relative proportion to its gradually increasing density. Thus (Fig. 1):

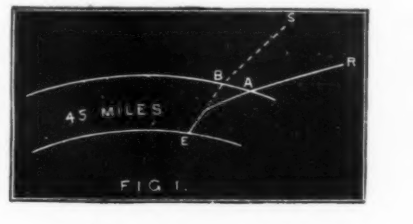


FIG. 1.

if R be a ray of light from the sun traveling *in vacuo*, it will travel in a direct line until it meet with the obstruction of the air at A, which, at the altitude of forty-five miles, will have but little density, still in proportion to this density, however slight, the ray of light will be inclined downward. The nearer it approaches the earth the greater, consequently, will be both the density of the atmosphere and the divergence of the ray; thus by the time it has arrived on the earth's surface it will do so at a very different angle to that at which it was traveling *in vacuo* before reaching the atmosphere. A man standing on the earth's surface, pointing toward what he conceives to be the center of the sun's disk (provided, of course, that the sun be not in the zenith, in which case no angle is made), is, as a matter of fact, pointing considerably above that center. This aberration of the rays of light increases with the distance of the sun from the meridian; as in rising and setting its light passes through a much greater body of air and of much greater density than at other times. It will be seen at once, that in the ray, R E, the distance between A and E is much greater than that between B and E in the instance of the ray, S E, while at the same time the density of the air is continually increasing in regular proportion between B and E, and A and E, the ray, R E, will pass through a denser medium *in toto* from A than from B toward E.

An exemplification of this fact may frequently be seen when the sun is setting; the aberration caused by the deflection of the surrounding rays of light causing that luminary to appear considerably magnified. The same thing may be observed at sunrise by those living on our Eastern coasts, and who are sufficiently wide awake, when that daily event transpires, to distinguish between the sun and a fixed star.

Thus it will be at once understood, that when we see the first portion only of the sun's limb above the horizon, as a matter of fact, it has not yet risen; what we see is not the sun but the refraction of the rays of light from that body, in consequence of the dense medium of the atmosphere intervening between our eye and the object, having bent down the rays to the angle, R A E. The common illustration of a coin in a bowl of water is frequently shown to prove the truth of this assertion. If a coin be placed in a bowl, and a spectator retires till he loses sight of the coin, it can be made to reappear by filling the bowl with water, it being a denser medium than air, thus causing the refraction of the rays of light between the air and the water.

This refraction is subject to an irrefrangible law, which is the same in kind, though different in degree, for various media in proportion to their density. Now, let us proceed to examine this law, and ascertain what direction a ray of light will take after impinging upon a medium of a different density to that from which it originated, and as our subject is more particularly confined to glass, let us take a section of that material, A B C D.

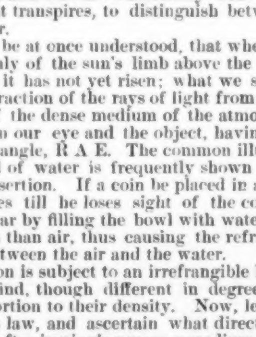


FIG. 2.

Now let a ray (Fig. 2), R E, impinge upon it, E being the point of impact. Were glass of the same degree of density as atmospheric air, the ray of light, R E, would pass through uninterruptedly until it emerged at X in the direction of the dotted line; but inasmuch as glass is of a greater density than air, it takes a different direction according to the following law: The sine of the angle of refraction is to the sine of the angle of incidence as two is to three. Let us now proceed to find the direction which will be taken by the ray of incidence, R E, after impact at E. Draw H K through E perpendicular to D C, and from the center, E, at any distance describe a circle cutting E R in O. Draw O S parallel to D C, and, on the opposite side of the line, D C, set off T P equal to two-thirds of O S. Join E P, and produce this line to meet A B in F, then the line, E F, will be the line of refraction that the ray, R E, will take after impinging upon D C at E, and entering the denser

* From a recent paper read before the London Foreman Engineers' Association, by F. A. Hamilton.

medium of glass. Thus it will be clearly seen that the sine, T P, of the angle of refraction, F E H, is equal to two-thirds the sine, O S, of the incident angle, R E K.

In these illustrations it is to be inferred that the glass used is reckoned as the best flint and free from impurities. It is needless to say that glass differs in quality, and consequently in density, and that a very different result is obtainable from inferior to that which is deducible from the best glass.

The ray of light having now passed through the sheet of plate glass emerges from the point, F, and it is found to follow a direction exactly parallel to the original incident ray. F G may therefore be safely drawn parallel to R X, thus the direction of the ray is similar, but is slightly raised bodily, in proportion to the thickness of the glass medium through which it has to pass.

Now, if instead of having one thickness of glass, A B D C, through which the ray has to pass, we have two placed together in contact, we should have to repeat the deflection, but on emergence the ray would revert to the same angle as that at which it entered. The ray (Fig. 3), R E, instead of

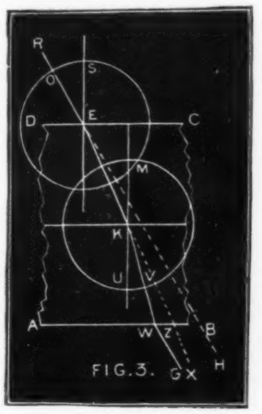


FIG. 3. G

passing on in a straight line toward H, would be first directed towards K, the sine, T P, being made equal to two-thirds of the sine, O S. Now a second refraction will take place, and the sine, U V, will have to be made equal to two-thirds of J M by the application of the same law as applied to E K. Now the ray on emergence at W will take the same course as it would have taken on emerging at K—that is to say, in a line parallel to R H, but, of course, from a somewhat higher point, owing to the double refraction, E K, K W.

If, however, the glass through which the ray of light is made to pass be not bounded by parallel planes—that is to say, suppose that the plane of incidence be not parallel to the plane of emergence, as in the triangle, A B C—the emerging ray, G, no longer travels in a line parallel to the incident ray, R E, but is diverted in a totally different direction. Now the mode of finding the courses taken by both the refracted ray, E L, and the emergent ray, L G, is by the adoption of the same rule that applies to the previous case, where the planes of incidence and emergence are parallel to each other, as I will now proceed to show.

Let (Fig. 4) A B C be a triangular prism, and let R be a

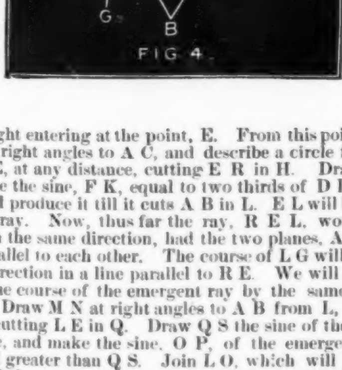


FIG. 4.

ray of light entering at the point, E. From this point, draw a line at right angles to A C, and describe a circle from the center, E, at any distance, cutting E R in H. Draw D H, and make the sine, F K, equal to two thirds of D H. Join E K, and produce it till it cuts A B in L. E L will be the refracting ray. Now, thus far the ray, R E L, would have passed in the same direction, had the two planes, A B, A C, been parallel to each other. The course of L G will not now take a direction in a line parallel to R E. We will proceed to find the course of the emergent ray by the same rule as before. Draw M N at right angles to A B from L, describe a circle cutting L E in Q. Draw Q S the sine of the refracting angle, and make the sine, O P, of the emergent angle one third greater than Q S. Join L O, which will give the course of the emergent ray. Thus the line of light taken by the ray, R E, will be that of E L G. This unalterable law, refraction, will always obtain until the critical angle is reached beyond which refraction cannot be carried, and this deflection is found to be at an angle of about 42°.

As we have now considered the primary laws that relate to and govern the deviation of rays of light by refraction, we will pass on to the other phenomenon—that of reflection. If a ray of light (Fig. 5), R, be allowed to pass obliquely upon a highly polished silver plate, A B, it will be seen after impact to proceed in an opposite direction, and this direction is determined by the angle at which the ray, R C, is delivered.

This angle of reflection is always equal to the angle of incidence. If the angle, G C R, be 45°, the angle, G C D, will be 45° also; if E C G be 80°, F C G will be 80° likewise.

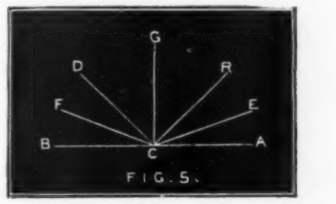


FIG. 5.

It follows from this proposition that were the ray of light to impinge upon the point C from G—that is, at right angles to A B—there would be no angle of reflection whatever, the ray returning to the point, G, from whence it came.

This principle is the same as that which governs the laws of sound and of force. Take the common illustration of the billiard ball, which it is quite possible some of you may have seen and experimented on. Let (Fig. 6) A be the striker's ball, and B the ball to be struck; it is quite clear to the most elementary player that if he strike the ball, A, full, and aim at the point, C, under the cushion, the angle that the ball will take after incidence will be the same as that which it took before and on leaving the cushion, that it must of necessity strike the ball, B, B C D being equal to D C E. If no ball were standing at B, however, the first would travel across the table continually impinging against the cushion, and as often rebounding therefrom at the respective angles of incidence, in proportion to the initial velocity given to it.

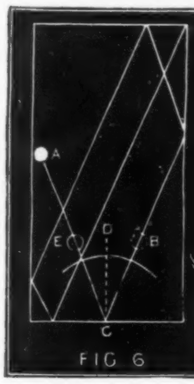


FIG 6

The ordinary mirror will reflect objects placed in front of it with a proverbial accuracy. The production of these images may be explained in the simplest manner by the law of reflection (Fig. 7). Let A B be a mirror, and R A, R B, two rays of light proceeding from the same point impinging upon A B. If we conceive the reflected rays, B D, A C, corresponding to them to be prolonged backwards—and the direction of which in accordance with the above laws admits of their being very easily ascertained—they will meet each other in the point, E X, the straight line, R E, which joins the point, E, with the luminous point, R, will be perpendicular to the plane of the mirror.

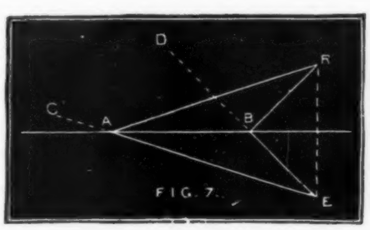


FIG. 7.

To take the order of our former illustrations of refraction, let us now suppose (Fig. 8) A C D B to be the section of a piece of plate glass, through which a ray of light passes. Provided the ray is stationed at the point, G, where there is no angle of incidence whatever, about 92 per cent. of the actual light delivered upon E will succeed in getting through and emerging at I, whereas if it were to strike from an angle of 80° with G E as F E G, the deflection would be so great that but a small proportion of the light would emerge from the opposite side of the glass, A C. In order, therefore, to enable the greatest amount of light to pass through the glass,

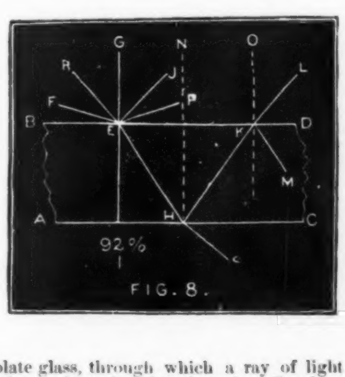


FIG. 8.

it is necessary that it should impinge upon the surface at right angles to the plane of the glass. The same thing exactly will apply to the line of emergence. Now the question naturally arises, What becomes of the light that fails to pass through when impinging at so obtuse an angle as F E D? The law of reflection here comes in conflict with that of refraction and diverts the rays that cannot penetrate through B D off toward P. This warfare between the principles of reflection and refraction is always going on, and in endeavoring to get as much light as possible by means of refraction we are always bound to pay a species of black mail to the counter law of reflection. The same principle of give and take, however, does not exist equally, for by reflection we can secure 92 per cent. of the incident rays, provided we arrange our prisms in a scientific position, but by refraction a considerable deduction must always be made as an allowance to reflection. All light that falls on a refracting surface does not completely pass into it; one part is reflected and scattered, while another penetrates into the medium.

To illustrate this more clearly let us take again our refracted ray of light, R S, passing through the plate glass with parallel planes, A C, B D. We have already seen that the ray, R, will be deflected at E, travel toward H, and emerge toward S in a parallel line with R E, but the law of reflection has something to claim out of the amount of light that seeks to pass through to H.

In the first place, at the point, E, there is reflection taking place towards J, the angle, G E J, being equal to the angle, G E R. Then there is a further surface upon which the ray impinges, that of A C at the point H. Here again another demand is made by reflection, which first of all takes the course, H K, making an angle, N H K, equal to E H N, and secondly, it diverges toward L at the point K, making O K L equal to G E R. Even this, indeed, does not exhaust the demands made by reflection, for by the same law which reflects E H toward K, H K will again be reflected toward M, but, of course, to a very limited extent. The polished surface of this plate of glass acts as a mirror, whilst at the same time it permits the object behind it to be seen. If a lighted candle be placed on one side the image is reflected. If a water bottle filled with water be placed at the same distance behind the glass plate as the candle is in the front of it, the illusory impression is produced of a candle burning while submerged in the interior of the glass. In this simple experiment lies the explanation of Professor Pepper's Ghost phenomenon.

Now it follows that if instead of allowing the ray, R, to pass out beyond H toward S, it be arrested by a highly reflecting substance, such as a film of the amalgam of tin on the surface, A C, a much larger proportion of reflected light will return out at K toward L, and the reflection, K M, will be also proportionately increased. This may be seen by practical illustration in the ordinary looking-glass, in which we proverbially see a double reflection, one the more powerful from the silvered side and another from the transparent polished front surface. Those who are in the habit of wearing spectacles, too, must have observed the double reflection of objects from behind constantly impinging on the extremities of each eyeglass, more particularly when the planes of the glasses themselves are parallel to a dark image. This is due to the same principle, the image from behind being reflected from each surface of the glass, and thus being seen by the eye from the angle of reflection.

Still following the same order of illustration that we observed with the laws of refraction (Fig. 9), let us now take a

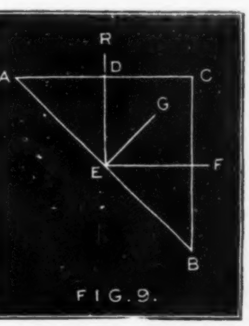


FIG. 9.

ray of light, entering from R, through a right-angled prism at the point, D. It needs but little demonstration to show, that passing in at right angles to A C, there will be nothing to impede the progress of the light until it be stopped at E, where it will impinge upon A B at an angle of 45° with G E, the normal angle, and of course will return at the same angle to F, which is also at right angles to B C. Had the ray, R, however, been delivered from a different direction to that of right angles with A C (Fig. 10) there would be a loss

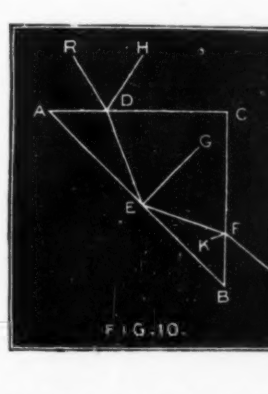


FIG. 10.

by reflection from D toward H and again from F toward K. There is also the deflection from the straight line in both D E and E F caused by the refraction of the ray, R D, in its passage through the prism. Thus it follows manifestly that in order to get as much light as possible to pass through the prism it must enter at right angles to A C, and emerge at right angles to B C.

Now let us do this (Fig. 11): draw A H at right angles to D R, and B K at right angles to L F; make B H parallel to E R, and A K parallel to R E, and then the figure, A B K H, becomes a double prism, through which light will pass by reflection with the least possible loss—that is to say, that

FIG. 11.

92 per cent of the light impinging upon A H will reappear emergent at B K, and the greater the deviation from this principle the greater will be the loss of light entailed in its passage.

Having now brought before you the principles by which the laws of light are governed in refraction and reflection, I wish to draw your attention to the practical use to which these laws have been applied in reflecting light into cellars, subterranean passages, and other places to which the direct light of heaven cannot gain access.

The original form of floor-light was a flat rectangular shape that admitted light perpendicularly only. The whole 92 per cent. of light passed through, provided the glass was of good quality, but if it were required to reflect the light to any distance on either side of the opening, the rectangular floor-light was useless. Next came the prism of 60° to each angle (Fig. 12). This was a great improvement on the old perpendicular form of light, for a light was thrown at an angle of 30° on each side of the prism. Not only so, but the whole of the light—92 per cent.—passed through, as will be seen in this diagram (Fig. 12). Let A B C be an equilateral

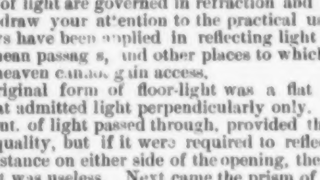


FIG. 12.

triangle. Now the light falling perpendicularly on *d, e, f, g*, will pass on uninterruptedly to *h, i, j, k*, they will then reflect at the same angle at which they impinged toward *l, m, n, o*, where they will pass out also at right angles. Thus no light whatever is lost by refraction, and the whole of the light, therefore, is utilized. It will be observed, however, that the direction of the light here reflected has an arbitrary course allotted to it. Moreover, half the light is directed to the right and half to the left; so that if it were necessary to have a large quantity of light directed toward the right, this form of floor-light would be of but little more value than the rectangular light spoken of above. Again, the only possible direction in which the equilateral prism can throw 92 per cent. of the light received into it, is that of 120° with the perpendicular ray—*i. e.*, 30° with the plane of the prism—and were any other angle required, it would in this particular also be useless. In consequence, therefore, of the inability of this form of prism to do more than throw rays in an arbitrary manner, both as to quantity and direction, other forms had to be designed to meet the difficulty, and which should give us light where we want it, and in the quantity we want it.

There is a form of prism very commonly in use of the shape indicated in the diagram (Fig. 13). The light falls di-

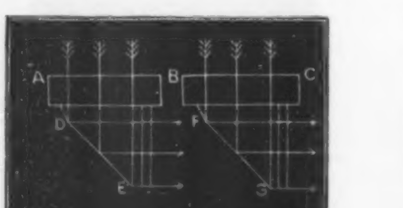


FIG. 13.

rectly down in perpendicular rays upon A B, B C, and impinges upon F G, D E. Now, as these planes are nearly at an angle of 45°, the light is reflected at the same angle, and consequently emerges in a horizontal direction, about the only direction in which it is not wanted. True, as there are a large number of these prisms, the whole of the light is not absolutely lost, for it impinges after emergence upon the inclined plane of its nearest neighbor and so becomes reflected vertically, first, however, having filtered through the prism. In point of fact, except for a certain portion of diffused light escaping from minor causes, a directly perpendicular light from a rectangular glass tile would positively be more suited to the purpose. Many other forms of prismatic floor-lights have been tried, as the diagrams on the walls will show, but whether the aid of science was brought to bear upon the forms that they should take, it is not for me to say further than to remark that I fail to see the evidence of any scientific application in any of the forms but that to which I have alluded. Now let me show how that form is to be obtained for any desired angle.

Let (Fig. 14) A B C D be the direct perpendicular light, and G E, H F the direction which the light is required to

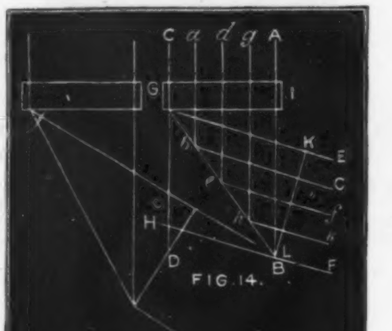


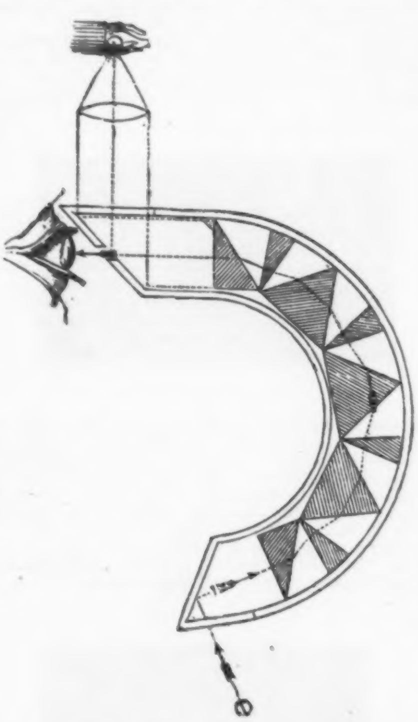
FIG. 14.

take. At the points of intersection, draw L K, G I at right angles to F H, D C, and join G L. The double prism, I G L K, will direct 92 per cent. of the light impinging upon A C through to E F, and there is no other form of prism possible that can succeed in doing the same thing. The law of optics is an irrefrangible law, and all the argument in the world will not alter its operation. I should call attention to another point in connection with this form of double prism which is not unimportant. It will be seen that not only do the rays enter and emerge at right angles to the planes of impact and emergence, but that every ray of light has an equal distance to travel—*i. e.*, *a b* and *b c*, *d e* and *e f*, and *g h* and *h k*, are all equal to one another, so that there is an equality of time occupied in the transmission of the light, no matter through which point in the prism the light passes.

NOVEL SURGICAL INSTRUMENT.

An electric lamp has recently been proposed for surgical and dental operations. Some years ago, says Mr. Thomas Stevenson, I designed an instrument for illuminating the dark cavities of the body which would, I think, be very serviceable in connection with an electric lamp.

This instrument consists of a series of prisms arranged somewhat as in the corona employed for spectrum analysis The accompanying woodcut will be sufficiently intelligible



without any detailed description. The different prisms are of glass of such refractive indices as to secure achromatism, and the rays of light are bent round corners, so as, finally, to reach an external observer.

In most cases one or two such prisms will be sufficient, but any number may be employed so long as the loss of light from absorption, superficial reflection, and other causes is not so great as to defeat the object in view by destroying the distinctness of the image.—*Engineer.*

DIPHTHERIA AND MILK.

There has long been a suspicion that milk was occasionally a carrier of the diphtheritic poison. It has even seemed probable that the diphtheritic poison originated with some morbid condition in the cow itself. It was shown in 1869 by Dr. Thorne that the milk from cows affected by foot and mouth disease was injurious to human subjects. About a year ago a committee of the London Pathological Society was appointed to investigate the relation between milk and diphtheria. Their work is not yet finished, but meanwhile several outbreaks of diphtheria have occurred in England, which show the importance of a more thorough knowledge of the matter. The history of these outbreaks has been given by Mr. E. L. Jacob.

On a particular day ten persons in the village of Weybridge were attacked with diphtheria. During the subsequent nine days fifty more had the disease. The epidemic then suddenly stopped. The persons affected were mostly of the better class, and were found to be living in all parts of the village. The only thing in common was, that all the families affected had milk from the same dairy. Twenty per cent. of the families supplied by this dairy had diphtheria. Eleven of these families had milk from two or three cows exclusively. Ten out of this eleven had diphtheria. The remaining 139 families supplied by this dairy had more or less of the milk from the same two or three particular cows. Twenty-one of these 139 families were attacked. The evidence pointed with great certainty toward the milk as the source of the infection, and, with less probability, toward the two or three selected cows. Investigation failed to discover any disease in the cows, or any especially bad hygienic condition about them. It was possible, however, that the cows had had some disease, or that the milk had been diluted with polluted water.

At the Princess Mary's Village Homes forty-eight persons were attacked with diphtheria. The water-supply of the farm which supplied the milk to the homes was found to be impure; one of the cows had the garget; and the epidemic began rapidly to decline eight days after the stoppage of the milk-supply.

In these cases the evidence is not so strong that milk was the cause. Still there was nothing to which the epidemic could be attributed.

At Leatherhead, in the course of six weeks, fifty-five persons were attacked with diphtheria. As respects water-supply, drainage, school-congregation, and personal infection, there was very little in common. Almost all of the families affected, however, had milk from the same dairy. Nothing wrong could be discovered at this dairy, except that the water-supply was not very good.

At Sutton, fifteen persons were attacked with diphtheria within two days. These persons lived in different parts of the town, and under good sanitary conditions, but they were all supplied with milk from the same dairy. Nothing wrong could be discovered at this place.

The facts thus given, though inconclusive, have very great importance as showing the necessity of a thorough investigation of the true relation of milk-supply to diphtheria.—*Brit. Med. Journ.*

SOME IMPORTANT TOPICAL REMEDIES AND THEIR USE IN THE TREATMENT OF SKIN DISEASES.*

By John V. Shoemaker, A.M., M.D., Philadelphia.

I propose to discuss in this paper some of the numerous agents which should be taken into consideration in the external treatment of skin diseases. In the first place my purpose is to point out the proper use of soap and to assist in preventing its indiscriminate use as practiced at the present day. Secondly, I shall endeavor to add some practical facts, and some new preparations to those that are known as the *oleates*, and, lastly, I shall refer to the great importance of mechanical remedies in the external treatment of skin diseases.

The first topical agent I shall refer to is soap. It will be necessary here to make reference to the natural condition of the skin, in order to understand properly the action of this remedy. The skin is provided with oily substances in which the impurities that are cast off by the system and the dirt from the air become adherent. In order to remove these impurities, the water that is used for cleansing the skin must be assisted by some chemical substance that will have the power of exerting an influence over these oily matters. The chemical substance used for this purpose is soap. Soap is readily dissolved in water, and, when applied to the body in the normal condition cleanses and purifies the skin, and so serves to preserve the health of the individual.

The use of soap is not only a valuable aid for preserving the skin in health, but is also of importance in assisting in the treatment of diseases of this organ. In the use of this agent for its remedial action on the skin, either one of two kinds—the soda or the hard, or the potash or the soft soap—can be selected. The hard or soda soap can be medicated with either bran, oatmeal, borax, carbolic acid, sulphur, chamomile flowers, almonds, or other medicinal substances or a combination of those already named; soap that is prepared in this manner is known as medicated soap. It is of great service in removing impurities and dirt from the skin, and in medicating the surface at the same time according to the medicinal substance held in suspension. For instance, it will be found that tar soap, by its astringent and stimulating action, is very valuable in certain stages of psoriasis; sulphur soap is of benefit by its stimulating effect in indurated acne, and carbolic soap is of great service for its cleansing, deodorizing, and astringent action in excessive secretion, and pustular affections. I have observed that a combination of different medicinal substances in the form of hard soap can be used with great benefit in some of the cutaneous eruptions. One especial combination that I have used with remarkably good result is composed of one and a half ounces each of olive oil and oil of theobroma, two drachms of powdered German chamomile flowers, one drachm of precipitated sulphur, and a sufficient quantity of caustic soda solution to saponify. This soap has a mild, stimulating action upon the skin. I have frequently used it for this purpose in place of soft soap with great success in stimulating old eczematous patches and in removing crusts and scales in seborrhœa and pityriasis. This form of soap has been prepared at my suggestion by Mr. L. Wolff, chemist and pharmaceutist, of Philadelphia, and I name it according to its ingredients (sapo matricariæ sulphurisque).

The second variety of soap may be prepared from either an animal fat or a vegetable oil, with an excess of caustic potash, and is commonly known as soft soap or sapo *viridis*. It is a soft, brownish or greenish-brown gelatinous substance with a strong caustic odor. These characteristics will vary very much according to the manner in which it is manufactured.

It can be applied to the skin either alone or in combination with water, alcohol, oils, or other medicinal substances. Its effect upon cutaneous surfaces will depend very much as to whether it is applied alone, or diluted with some other preparation. When applied to the skin in full strength it is a moderately good caustic. It is endowed with far greater power of diffusion into the tissues by the potash that it con-

* From the Transactions of the Medical Society of the State of Pennsylvania.

tains than the soda soap, and should therefore be used with great care upon delicate surfaces. I have found that the indiscriminate use of this soft soap with its penetrating and destructive action on the tissues has brought on an immense amount of mischief by awakening violent and obstinate inflammation of the skin. It has, however, been used with great benefit alone and in combination in treating parasitic affections, more especially scabies, but it should be employed with great caution in all cases.

The Oleates.—The second medicinal remedy that I shall consider in this paper was recently introduced into practice by Mr. John Marshall, of England. These remedies are exceedingly valuable, and possess, in certain diseases, many advantages over ointments. In the first place, oleic acid possesses solvent powers that are more active than most bases of ointments, and consequently the chemical combination so formed will be more potent when applied to the skin. Further, they will not decompose like ointments, and on this account will be more effective and not act as irritants to the skin. When the oleates are prepared either as a 5 or 10 per cent. solution they are all, with the exception of the oleate of zinc, in the liquid state, and will therefore have a greater absorbent power. They will also penetrate deeper and more rapidly into the tissues than ointments. And, lastly, as they are of a liquid condition, with one exception, they are better suited for applications over the scalp, the beard, axillary and pubic region, or any hairy part of the body, in preference to ointments, which frequently mat together the hairs.

Mr. Marshall, in his valuable paper on this subject, refers to the powerful action of the oleates of morphia and atropia in allaying pain and nervous irritation, and also to the advantage of employing the oleate of mercury in sycosis, chloasma, pediculi, syphilitic affections, and other morbid conditions. Since the publication of these practical observations I have frequently had occasion to apply the oleates as external remedies in the treatment of skin affections, with the most happy results. In addition to their value in the diseases named by Mr. Marshall, I have also found that the oleates of atropia and mercury are equally efficacious in other cutaneous affections. I may first mention that the oleate of atropia (one grain of atropia to the ounce of oleic acid) exerts a marked influence in arresting the abundant secretion of seborrhœa and in subduing high inflammatory action in some cases of erysipelas. Secondly, I have observed that a 10 per cent. solution of the oleate of mercury, with the addition of a small quantity of olive oil, and scented with some essential oil, is an invaluable application for general thinning and loss of hair. When brushed lightly over the scalp in the above condition it produces both a tonic and alterative effect upon the part. I have also employed as an application with great success a two ounce solution of the oleate of mercury, of 10 per cent. strength, mixed with an equal quantity of olive oil in psoriasis and pityriasis, after all the redness and scales have disappeared. The use of this preparation in these affections protects and soothes the hyperæmic skin, and prevents a return of the diseased condition.

Mr. L. Wolff has also lately made for me, after many tedious experiments, two additional and valuable preparations of the oleates; namely, the oleates of led and bismuth. And I believe I have been the first to use these remedies as topical applications in cutaneous affections. The former of these agents, the oleate of lead, is manufactured by adding liquor potassæ to a diluted preparation of liquor plumbi subacetatis, and the precipitate collected on a filter and dried. The dry suboxide of lead should then be dissolved in oleic acid by means of the water-bath. The strength of the solution should be 5 per cent. of lead to the oleic acid, and as free as possible of stearic and margaric acid, in order to have it in the liquid form. Should either the per cent. of lead be increased or the solution contaminated by stearic or margaric acid, the oleate will be semi-solid, and will not have the same efficient action. The oleate of lead is an opaque oily liquid, if prepared with care in the manner that I have indicated. It is a mild astringent, more readily absorbed than either Goulard's cerate or (Hebra's) litharge ointment; while it possesses the advantage of neither decomposing nor turning rancid. I have obtained remarkably good results from its use in eczema, in rosacea, after depletion of the parts, in burns, and in erythema. It arrests morbid discharges, protects the surface, and allays irritation by its astringent and sedative action.

The oleate of bismuth, an oily-brown liquid, the second one of these new preparations of oleates, is not so difficult to manufacture as the last named, and I will therefore omit the manner of preparing it. It, however, possesses valuable medicinal effect when applied in pustular eruptions, especially in sycosis and herpetic affections. It is, also, a most useful remedy in soothing and relieving cutaneous irritation when mixed with an equal quantity of olive oil and applied in acute specific eruptions, especially in scarlet fever.

The last, and by far the most important agents that I shall discuss are the mechanical remedies, whose value, however, has not been sufficiently estimated, notwithstanding the strenuous efforts that have been made by a few physicians to bring them into more general notice. In regard to the use of these remedies I shall confine my remarks to two or three of them as deserving of particular attention. I shall first allude to friction, secondly to compression, and thirdly to bloodletting.

Friction is a valuable antiphlogistic agent, and is capable of doing much good when judiciously employed. It may be applied with either the dry hand, brushes, a rough towel, or with liniments. Its great value consists in stimulating the part so that any impediment in peripheral circulation may be aroused, and thus promote the removal of all effused material. That it is capable of doing an immense amount of good is certainly apparent when the scalp is rubbed and brushed in thinning and loss of hair. This active friction in a diseased state arouses the sluggish circulation and adds tone and vigor to the scalp and hair; similar effects are observed when friction is made over the skin in which the pigment is in excess, or deficient in quantity. The stimulation, so excited, helps the skin to recover its healthy state. Another beneficial effect of this agent can be witnessed in indurated acne, and in glandular swellings of the skin. The friction so employed arouses the circulation and so relieves the glandular congestion. Friction has, likewise, been used with great advantage in dry seborrhœa, in chronic lichen and eczema, and in certain neuroses of the skin. In using friction in cutaneous diseases a certain amount of judgment is requisite in its application. It should not be employed either too frequently or too violently, as it may occasion much mischief by aggravating the morbid action. Thus, it will be seen that violent brushing of the scalp often sets up an attack of eczema, and roughly rubbing the face in acne may excite erythema of the part. From these facts it should be borne in mind that friction should be carefully employed, according to the exigencies of each particular case.

A practical knowledge of *compression*, the second mechanical remedy that I have enumerated, is of great service, and should receive more attention from the active practitioner in the treatment of cutaneous diseases.

The means usually made use of for compression are the common muslin and gum bandages, and plasters. Compression, when employed in this manner, soothes muscular irritation, tones up the dilated capillaries, and prevents the escape of serosity into the tissues. It will be found that these effects are not by any means the only benefits that are realized from compression. It will also be seen that it will enable the vessels to remove poured-out fluids, protect denuded surfaces, and exclude the air which is very stimulating to inflamed and irritable parts, and so moderate diseased action. The treatment of cases of chronic eczema of the leg, in which the surface is livid and covered with ulcers, by a muslin bandage, will afford a satisfactory example of the efficacy of this method. In a short space of time, after using the above means, the excessive irritation and congestion disappear, and the ulcers promptly take on a healthy condition. On the other hand, experience has verified the fact that the gum bandage is more elastic and is always to be preferred when it can be procured, on account of the equable pressure that it makes over the whole limb. The bandage will also have a similar effect on other chronic and inflammatory conditions of the skin, by the systematic pressure that it produces.

Compression can likewise be made with plasters, and they can be either simple or medicated. The common adhesive plaster, however, usually answers all purposes, although opium, balladonna, mercury, soap, pitch, or other medicinal substances can be used when necessary. The beneficial influence of plaster cut in strips and applied to the surface is most strikingly evinced in eczema of the lips. The mucous surface in this disease is torn open with every movement of the lips, and all the lotions, ointments, and powders will not soothe the muscular irritation and heal the parts until they are protected and placed at rest. In order to accomplish this purpose, adhesive strips can be made to encircle, and allowed to meet posteriorily at the nape of the neck. In this manner the movement of the lips is controlled, the raw surface protected, the irritation soothed, and the disease promptly and effectually arrested. In removing the adhesive strips, in cases of this description, care should always be taken to detach both ends and draw gradually to the center; otherwise, the mucous surface may again be torn open.

Compression made in a like manner is admirably adapted to the treatment of that variety of dry and cracked eczema that attacks the hands and feet. If the adhesive strips in this condition are wound around the hands or feet, the muscular action on the inflamed surface will be arrested, the parts protected, and with the addition of appropriate internal treatment the most obstinate cases will rapidly recover. The same end may be obtained in fissures of the hands, by having India-rubber gloves made which will fit nicely, and so make equable compression. The employment of this agent, twelve hours during the day, not only makes suitable compression, but protects the hands from the many irritating substances with which they daily come in contact. A certain amount of care should be exercised in using compression, in order to prevent making too much pressure on the part, and thus arresting the circulation. It should always be applied so as to support, protect, and place the tissues at rest.

I shall next proceed to the consideration of local bloodletting as a mechanical remedy in the treatment of skin diseases. It is one of the most powerful antiphlogistic agents that we possess. It is, also, one of the most speedy and most efficient means of combating morbid conditions, after all our other medicinal agents have been exhausted in vain attempts to cure certain eruptive diseases.

Blood may be extracted, locally, by leeches, cups, scarification, or punctures. The manner of applying leeches and cups is so well known to all that it is unnecessary to enter into a description of either method. I think, however, for topical bleeding in skin diseases, that scarification and punctures are all the forms that are necessary to be used. In scarifying or puncturing a part, the blood that has engorged the vessels and the effused serum in the tissues are allowed to escape. In addition, it relieves the tension and congestion of the part and awakens the action of the absorbent vessels. Scarification can be performed with either a lancet or the bistoury, and is particularly applicable to chronic ulcers and ulcerating lupus.

In the great majority of cases, however, that require depletion in cutaneous diseases, I usually puncture the surface with a small needle knife. I have employed this method of treatment with success in inflammation of the hair follicles of the beard, in acne, in enlargement of the bloodvessels of the face, in chronic eczema, in excess of pigment of the skin, and in neuroses. Thus, in inflammation of the hair follicles of the beard, depletion in this way relieves the engorged glands, and drains off altered and vitiated blood. A similar effect is produced in acne, by allowing the stagnated blood and the broken-down sebum to freely ooze from the small incisions. Again, the abstraction of blood, by puncturing the surface, in enlargement of the bloodvessels of the face and in chronic eczema, especially where there is a large quantity of hypertrophied tissue, is an invaluable remedy. In these diseases it relieves the congestion and stagnation of the blood in the vessels, equalizes the circulation, and so stimulates the action of the absorbent vessels that all deposits may be carried off. Puncturing is equally efficacious in arousing the torpid tissues to activity in excess of pigment of the skin, and in allaying the pruritic troubles of old age. I have relieved, and, with appropriate internal treatment, have cured some of the worst cases of pruritic difficulty in old persons by the above method of puncturing over all the diseased surface. This application blunts the irritation of the cutaneous nerves, and relieves the capillary congestion set up by the morbid condition of the part. After puncturing the surface, it should be allowed to bleed freely by the application of warm or hot water, either one or the other of which I use in all cases of local abstraction of blood. The relief afforded by this method of treating many cutaneous affections will be best manifested by patients wishing a repetition of the operation, as has been my experience again and again in both dispensary and private practice.

MANGANESE GERMAN SILVER.—A species of German silver is manufactured by Biermann and Clodius, of Hanover, of the following proportions, in which manganese is substituted for nickel: copper 72·25, manganese 16·57, zinc 8·75, iron 2·43 per cent. The alloy is said to be unaffected by immersion for 40 days in water.

OBESITY—A FEW THOUGHTS ON ITS NATURE AND TREATMENT.*

THE quite common occurrence of that abnormal condition known as obesity taken in connection with the abhorrence which is generally entertained regarding it, and the scarcity of literature on the subject, induces the belief that what is here offered may not be received with disfavor.

It is a fact to which no one can close his eyes that the many advantages, amenities, and luxuries of civilized and enlightened communities are not unmixed goods, but that they are alloyed with much that is tended to lead us to inquire whether after all, they are for the good of the race. The means whereby ease and comfort are secured are too often so perverted and abused as to entail pain and discomfort. Many facts might be drawn from every-day life in demonstration of this assertion, but for the present, let that furnished by obesity, or an abnormal accumulation of adipose, suffice. The physical degeneration, and to a certain extent also, the mental, of a people dates from its indulgence in luxuries. History furnishes numerous illustrations of this proposition, and in our own day the lithe muscular form, and active, graceful motion of the savage is in marked contrast with the condition of men under the influences and habits of refined society. A fat, corpulent Indian, for instance, in his native state, with pendulous abdomen and Falstaffian circumference would be a monstrosity; but when he is brought under his white brother's sway, corpulence even to obesity not unfrequently deforms him.

These hints may serve to turn the mind into a channel wherein will be found much to support the assertion that obesity is an abnormal condition, and that it is the result of a transgression of fixed physiological laws, and differs in this respect, in no wise, from diseases in general. It will, however, be more proper to style and regard it rather as a symptom than as a disease *per se*, and for precisely the same reasons that we regard dropsy not as a disease, but as a symptom pointing to a disease seated in the liver, heart, kidneys, etc. Obesity is a sympton of disease, either functional or structural, and located chiefly in the chylopoietic system, and herein lies the secret of its relief—a secret which, either not recognized or disregarded, has been the cause of the unsatisfactory results of treatment which has heretofore been recommended.

The dangers attendant on obesity are usually underestimated. Most people, many physicians included, regard the condition as objectionable only on account of the obstacles it interposes to easy and facile movements of the body, and leave out of account entirely its elements of positive danger —its interference with the respiratory function, and the consequent deficient supply of oxygen to the blood, the overloaded condition of the blood with the products of faulty assimilation and excretion which always obtains, the accumulation of fat around vital organs, and its invasion of the structure of these organs, the fatty degeneration of the heart, liver, kidneys, and even brain itself, etc. The fat man has a much more uncertain tenure of life than has the man of physiological development, a fact which is recognized by all life insurance companies. A careful insurance company will not take a risk on an applicant whose weight as compared with his height is greater than the proportion which experience has abundantly shown to properly and physiologically exist.

That abnormal deposit and accumulation of fat known as obesity, like all other diseases, has its causes, although as in all other diseases that cause is not unfrequently obscure. For practical purposes, and in fact, also, there are two kinds of obesity, active and passive. The former comprises the "fleshiness" of people of active pursuits, whose appetites are keen, whose digestion is faultless, and whose powers of assimilation are active. The other variety, that of passive obesity, is that condition which obtains in persons in whom the phlegmatic temperament predominates, whose habits are more or less sedentary, whose excretion is defective, and who imbibe large quantities of fluids. The essential condition in these varieties, viz., the deposit of fat, is, of course, the same, but the methods are different, and consequently the treatment is different in each.

Different temperaments are differently disposed, both in regard to fat producing and fat accumulation. The man of the purely nervous temperament, or in whom the nervous temperament predominates, may gorge himself habitually with impunity, as far as obesity is concerned. He may eat all sorts of carbonaceous (fat forming) diet, and, notwithstanding that he may take but the minimum of exercise, he remains as void of adipose as Pharaoh's lean kine. These are men whose lives are physiologically fast, and they wear out earlier than those whose functions are less active. In persons in whom the lymphatic temperament predominates, fat forms, and is deposited very readily. In such the vital functions are relatively inactive, and if they are abstemious and regular in their habits they are likely to wear to an old age. In them, however, there exists a greater liability to obesity, to avoid which, constant vigilance in habits and dietary is imperative.

Hereditary predisposition to the accumulation of fat is apt to be regarded as offering an insuperable obstacle to treatment. There can be little doubt that such an influence presents great difficulties, but it does not call for any modification of the principles on which treatment should be conducted, except that these principles should be all the more uncompromisingly adhered to.

The foregoing general remarks, which have been made as brief as possible, consistently with clearness, have been deemed necessary to an intelligent consideration of the subject of the treatment of obesity. This treatment involves three essential factors: diet, exercise, and medication, the relative importance of which is in the order in which they are named.

DIET.

In considering the subject of diet the part which the different kinds of food perform under physiological conditions must be taken into account. Different tissues of the body require for their upbuilding and support food into which special elements enter. In the production of bone, the various salts, and notably the phosphates, are requisite; for muscle, nitrogenous diet is essential, and for the adipose tissue, non-nitrogenous or carbonaceous material must be taken. It follows, then, that where either of these principles is supplied in increased quantities, other things being equal, the tissue to which they have a special determination is proportionately nourished and increased in physiological properties, and, *per contra*, a diminution of their supply will result in corresponding deterioration. The application of these principles in the treatment of obesity is at once

* A paper read before the Wayne County Medical Society, by J. J. Mulheron, M. D., Detroit, Mich.

easy and direct. It goes without the saying that the first step is to limit the supply to the physiological demand. To do this effectually requires intelligent co-operation, and, at times, no little self-denial on the part of the patient, without which treatment may as well be abandoned at the very outset. Simple as the question of diet may appear on its face, it is one which cannot be governed by arbitrary rules, but which requires intelligence and a knowledge of physiology to properly conduct it.

The system of Banting was devised by one who had not a proper appreciation of the laws of health, and although it succeeds in reducing adipose, it does so at an expense to the general health, which is out of proportion to the benefits it insures. When first introduced this system achieved quite a popularity in England, but it is now no longer held in such high favor, the evils attendant on it having become apparent, and experience having shown that the end sought may be secured without these evils. Bantingism consists essentially of a course of diet confined to nitrogenous food, and is, therefore, a system which feeds the muscular tissue, and starves the adipose. The dangers of such a diet lie in the nature of the effete material with which the system becomes charged in consequence of its prolonged use. Only a certain percentage of the food taken into the stomach is appropriated to the needs of the tissues. If the amount taken be not excessive, so much as is not appropriated is carried off by the natural channels. That which from its excess is neither appropriated nor got rid of naturally, remains to undergo such decomposition in the system as is peculiar to its nature. In the case of nitrogenous food, urea is the chief product. A reference to those diseases of the kidneys, for instance, in which the normal elimination of urea is interfered with, is sufficient to convince one of the dangers attendant on its presence in abundance in the system. The dangers of smaller quantities are different in degree rather than in kind, and the person fed on a superabundance of nitrogenous food suffers, in addition to the direct mischief, the protean evils attendant on the indigestion which almost invariably afflicts him, as gout, rheumatism, vesical irritation, etc. But a consideration of these would open up a field foreign to our purpose on this occasion. In order, therefore, to preserve the general health, carbonaceous (fat-forming) diet cannot be wholly eschewed. It must be partaken of, however, only in such amount as will admit of the complete oxidation of that which is not appropriated by physiological requirements.

Enough, we trust, has been hinted at to justify the statement that no arbitrary rules of diet can be prescribed for the obese. The nearest that can be laid down by way of a rule is to specify the varieties of food to be taken, and their proportion, and then to leave the amount to the intelligent judgment of the patient. In arranging the dietary, however, he whose obesity is of the passive variety, of which we have spoken, should let the principal part of his food be of nitrogenous material, as beef, for instance.

It is impossible to prescribe in pounds and ounces the amount to be taken; that which may be simply enough for one man may be too much for another, and *vice versa*. The patient must by experience learn to take the least possible amount consistent with his general well-being, and it will astonish him when he finds out how little it is actually necessary for him to take. People, as a rule, eat too much, and no small percentage of the diseases with which men are afflicted, to say nothing of obesity, are owing, directly or indirectly, to the constant tax imposed on the system in its getting rid of superabundant food.

One thing, however, must be insisted on in connection with the subject of diet, and that is a restriction on the amount of fluid ingested. A large proportion of the obesity which abounds consists of water in the tissues, and in many instances if corpulent people were submitted to a process of evaporation, their weight would be quickly and materially reduced. The obese person should, therefore, take his food as nearly dry as possible, and should imbibe as sparingly as possible of fluids. Soups, etc., should be entirely banished from the dietary.

EXERCISE.

The necessity of exercise, by which we mean alternate contraction and relaxation of the voluntary muscular fiber, is too obvious to require argument, and yet the lack of exercise is one of the most fruitful causes of disease. It is not my purpose to discuss the precise effects of this exercise on the secretions. This is a question full of interest, and of much importance to the hygienist, but for our present purpose it is only necessary to remark that exercise increases oxidation. The union of oxygen and carbon produces the phenomenon of combustion, and the carbon (fat) which is deposited from the circulation remains, and accumulates in the tissues as it fails to come in contact with the oxygen. It follows, therefore, that diminished exercise conduces to this accumulation, and that *per contra* increased exercise, through which the blood is charged with oxygen, by bringing an increased quantity of this element in contact with the fat increases the combustion and removal of the latter. We are frequently told by corpulent patients—women most frequently—that they are small eaters. In individual instances, this may be true, though we generally receive such statements *cum grano salis*, but it is almost invariably true in such cases that the subjects are sybarites, living on the choicest food, and spending their time in luxurious ease, and grow fat because of a comparative lack of oxygenation.

Exercise conduces to the removal of obesity also by starting up perspiration, and in this way, in addition to increasing the exhalation from the lungs, removing the fluid which enters so largely into the composition of the abnormal accumulation of adipose. With this brief reference to exercise as a factor in treatment, we leave it by insisting on its importance.

MEDICATION.

Notwithstanding the disrepute into which medication for the reduction of obesity has been brought through the anti-fat nostrums which have been placed before the public, there is no doubt that there are articles in the materia medica which, when intelligently administered, are capable both of assisting the removal of an abnormal accumulation of fat, and also of modifying conditions of the system on which this accumulation in a measure depends. The majority of those who present themselves for treatment are of the lymphatic temperament, or are those in whom this temperament predominates. In such cases there is a sluggishness of the lymphatic circulation, and a consequent diminished absorbent capacity. Agents, which experience has proven to be most serviceable in the reduction of fat, have been of the so-called alterative class, and particularly articles of the haloid series. Of the latter, again, iodine and its combinations have proven the most successful. This agent acts in a twofold manner. It is one of the most distinctive alteratives of the materia medica, and its effects in obesity are scarcely less marked on the lymphatic system than they are in those diseases in which iodine is by common consent *par excellence* the remedy. In addition to this alterative action, and perhaps in virtue of it, iodine directly increases waste, and the elimination of the products of waste. So well recognized is this fact that "emaciation, with a general depression of the vital functions," is laid down as one of the physiological effects of the continued use of large doses of this metalloid and of its salts.

I wish to call attention to an article which has recently achieved some prominence as a remedy in obesity, *Fucus vesiculosus*. It is said that the efficacy of this article was discovered accidentally by M. Duchesne Dupare, while administering it in a case of psoriasis. The patient, a corpulent person, became remarkably lighter, while at the same time there was improvement in the eruption, and in the general health of the patient. This experience in the effects of *Fucus vesiculosus* on the adipose tissue was confirmed by subsequent trials of the article, both in his own hands and in the hands of others. It is now regarded as an efficient adjuvant in the treatment.

An analysis of *Fucus vesiculosus* shows it to be rich in iodine. It is, in fact, from the burning of sea-weeds similar in their nature to *Fucus vesiculosus* (sea-wrack) that *kelp*, the great source of iodine, is derived. A knowledge of its constitution would therefore have been sufficient to have pointed it out as a remedy on theoretical grounds alone.

The effects of many medicines are more prompt when administered in organic combination than when isolated. This is abundantly illustrated in the case of pepsin, pancreatin, vitalized hypophosphites, wheat phosphates, etc. The various salts, also, which enter into the formation of the skeleton are more readily assimilated when taken in the form of organic food than when taken in their pure inorganic state. Doubtless the very excellent results which have been reported as following the administration of *Fucus vesiculosus*, and its superiority over its constituents when the latter are administered separately, are owing to the fact of the organic combinations into which these constituents have entered in the plant. It is, however, in the obesity of those of the lymphatic temperament, above alluded to, that the beneficial effects of this drug are most marked. It has little or no influence in reducing the "fleshiness" of persons of active habits, and of the sanguine temperament. In these, strict regulation of diet affords almost the only prospect of relief, but, owing to the keenness of the appetite which usually exists, this regulation can very rarely be enforced. The cases in whom *Fucus vesiculosus* shows its most decided beneficial effects are women, in whom there exists, usually, some menstrual derangement, as menorrhagia and leucorrhœa, owing to an atonic and flabby condition of the uterine tissue. In such cases an improvement in these local derangements usually precedes the general reduction of fat, and the improved tonicity of the general system.

In conclusion, I must remark on the difficulties which usually attend the treatment of obesity. The condition is most frequently found to exist in persons in whom strength of will and determination of character are somewhat deficient, and whom it is, therefore, very difficult to confine to the strict rules so necessary to successful treatment. When, however, the patient can be brought to submit himself to the control of his medical adviser, and to exercise the necessary self-control, the prospect of relief from his condition may be regarded as reasonably good.

THE DISTINCTIONS BETWEEN CROUP AND DIPHTHERIA.

THAT croup and diphtheria are distinct diseases is maintained by Dr. W. H. Day, in the *Medical Press and Circular*, and he points out the following distinctions:

We constantly meet with genuine croup, of an acute and local inflammatory character, leading to the well-known false membrane in the trachea and larynx, as described by the old-fashioned authorities. It seems impossible that we can mistake this true croup (which we have been in the habit of meeting with all our lives) for the peculiar membranous inflammation of the trachea sometimes seen in cases of diphtheria. It is well to glance at some remarkable points of difference in the two affections.

1. True croup is prone to attack the healthiest children, and in districts where diphtheria does not prevail.

2. True croup is apt to come on very suddenly, and in cases of recovery the general health is rapidly re-established, as compared with diphtheria.

3. In diphtheritic croup the disease is of a well marked character, and is always accompanied by a great depression and nervous symptoms.

4. Croup is a local disease; diphtheria is a constitutional affection, in which the kidneys and intestines may be involved. Croup is neither infectious nor contagious; diphtheria is both.

5. The cases that recover from diphtheritic croup are few, and the convalescence is not only very slow and tedious, but the throat affection is usually preceded by a characteristic membrane on the palate, and the prostration is always great. Partial loss of voice, fetid breath, swollen neck and glands, diminution of muscular power, paralysis of the muscles of deglutition, and albuminuria, are common in diphtheria; but they are not witnesses in inflammatory croup.

6. Between croup and diphtheria there is also another very important diagnostic difference; diphtheria generally begins in the pharynx, croup in the larynx. The false membrane found in the larynx in cases of genuine croup is quite different from the leathery or yellowish gray exudation found on the tonsils, in the larynx, and bronchial tubes, in cases of diphtheria. The pathological differences between croup and diphtheria are open to further contrast. In the early stage of croup there is an increase in the vascularity of the affected membrane, as in severe catarrh, with a trifling amount of inflammatory exudation. This is succeeded by fibrillation of the exuded lymph, which, with the new formed cellular elements becomes transformed into the characteristic *false membrane*. Its consistence varies, being in some cases tough, in others soft and amorphous, and easily removed from the mucous membrane beneath. In the larynx and upper part of the trachea, where the inflammation is most acute, the exudation is croupal or membranous, and is very characteristic of true croup, but in the lowest part of the trachea and diverging bronchi there may be nothing more than a scanty superficial layer of mucus.

"It is difficult in many cases to draw any line of demarkation between the histological changes occurring in diphtheria, and those of croup. In diphtheria, however, the submucous tissue usually becomes more extensively involved, so that the false membrane is much less readily removed. The circulation also often becomes so much interfered with that portions of the tissue lose their vitality, and large ash-colored sloughs are formed, which, after removal, leave a considerable loss of substance."

7. If croup were identical with diphtheria, it seems to me that the operation of tracheotomy would rarely succeed; whereas it is often successful when false membrane has blocked up the tracheal tube, and has been removed from time to time after the operation.

EFFECTS OF TEA ON THE SYSTEM.

DR. W. J. MORTON, of New York, describes a nervous disorder, resulting from excessive tea drinking (*Journal of Mental and Nervous Disease*, Oct.), and adds these general conclusions on the subject:

1. With tea, as with any potent drug, there is a proper and improper dose.

2. In moderation, tea is a mental and bodily stimulant of a most agreeable nature, followed by no harmful reaction. It produces contentment of mind, allays hunger and bodily weariness, and increases the incentive and the capacity for work.

3. Taken immoderately, it leads to a very serious group of symptoms, such as headache, vertigo, heat and flushings of body, ringing in the ears, mental dullness and confusion, tremulousness, "nervousness," sleeplessness, apprehension of evil, exhaustion of mind and body, with disinclination to mental and physical exertion, increased and irregular action of the heart, increased respiration.

Each of the above symptoms is produced by tea taken in immoderate quantities, irrespective of dyspepsia, or hypochondria, or hyperæmia. The prolonged use of tea produces, additionally, symptoms of these three latter diseases. In short, in immoderate doses, tea has a most injurious effect upon the nervous system.

4. Immoderate tea drinking, continued for a considerable time, with great certainty produces dyspepsia.

5. The immediate mental symptoms produced by tea are not to be attributed to dyspepsia.

In the above experiment upon myself, the whole group of symptoms was produced, with no sign of digestive trouble superadded.

6. Tea retards the "waste," or retrograde metamorphosis of tissue, and thereby diminishes the demand for food.

It also diminishes the amount of urine secreted.

7. Many of the symptoms of immoderate tea drinking are such as may occur without suspicion of tea being their cause; and we find many people taking tea to relieve the very symptoms which its abuse is producing.

THE MOTOR FUNCTIONS OF THE BRAIN.*

QUESTIONS which are the order of the day with the medical world do not remain long confined to the special center where they originated; and the public, becoming more and more initiated every day into the transactions of learned societies through proceedings published in political and scientific journals, very quickly interests itself in the researches which are being pursued in all branches of science. Its attention appears to be especially attracted by medical discussions, from which it has a right to expect practical results. So it usually receives with some interest the attempts that are made to furnish it with general ideas upon a subject of which it knows only certain features.

It is an essay of this nature that we wish to make at the present time, by explaining in a concise manner the relations that exist between certain regions of the brain and the exercise of voluntary movements.

The brain, as we know, exhibits a mass of nervous substance contained in and protected by the cranium; enveloped in tough and vascular membranes; and swimming, so to speak, in a liquid whose mobility permits it to undergo, without compression and without shock, expansions of considerable proportions and movements that are often abrupt. Like all the central parts of the nervous system, the brain is composed of nervous filaments, which form the *white substance*, and nervous cells, whose union constitutes the *gray substance*. These two substances, white and gray, are intimately united, the first occupying the central portions of the brain, and the second forming a sort of superficial mantle called the *cerebral cortex*. On this cortex has devolved the principal *rôle* in the working of the brain; in it terminate the impressions from all parts; in it these impressions are transformed into sensations; and in this cortical layer too are elaborated those impulses which preside over voluntary movements. The white substance, formed of conducting nervous tubes only, conveys the peripheric impressions to the gray cortex of the brain, and leads away from it the motor impulses that have arisen therein. The essential point that we are to touch on here is the precise location, in certain regions of the cerebral cortex, of those motor influences which preside over voluntary movements.

This special selection of definite cortical territories in the production of movements rests on a great number of pathological and experimental facts. All physiologists and physicians, however, do not accept the localization of motor functions in the brain without some reserve; and some of them offer in opposition certain criticisms on the experimental processes employed in inciting movements in animals, while others cite pathological facts which appear to them to be irreconcilable with the idea of an exact localization. We shall have to notice these objections, without, however, going into a complete discussion of them; our object being rather to show upon what experimental and clinical facts the theory of cerebral localization rests.

When we examine the surface of the brain of a man or of one of the higher animals, we observe folds of nervous substance which are known as "convolutions," these being separated by furrows.

The higher the position of the animal in the scale, the more numerous and conspicuous are the convolutions; and consequently it is in man that they exhibit the greatest complication. This complication, however, has not prevented a correct nomenclature and complete topography of the human brain being made. In fact, every group of convolutions has been named according to its situation in respect to one region or another of the cranium; and such convolutions, for instance, as the *frontal*, *parietal*, etc., have been described. In each of the groups thus determined, the convolutions are distinguished from each other according to their relative height and according to the place that they occupy on the corresponding hemisphere, etc. We say, for example, counting from above downwards, the first, second, third, right or left frontal convolution. They are also distinguished according to their longitudinal or vertical direction. Thus we have the ascending frontal, ascending parietal convolutions, etc.

* Translated and condensed from *La Nature*.

Confining ourselves to these brief notions, the only ones that are necessary for our present purposes, we may say without further preliminaries that the motor functions of the cerebral cortex have been localized in these anterior fronto-parietal regions, and especially ascribed to the *ascending frontal* and *ascending parietal* convolutions, as well as to the *third frontal convolution of the left side*. The facts that have led physicians to conceive of certain regions of the cortex being affected in the exercise of voluntary movements are the circumscribed paralysis observed in autopsies made upon patients after death, and in whom no other lesion could be found than a partial destruction of the cortex, located exactly upon the ascending frontal convolution or upon the ascending parietal. It has also been ascertained that persons who have lost the faculty of articulate speech in consequence of an attack of apoplexy in most cases exhibit, upon autopsy, a circumscribed lesion in the third left frontal convolution. From these observations medical men have come to the conclusion that there is a relation between the limited region of the brain and paralytic disorders. They located, for example, the faculty of articulate language (the loss of which constitutes *aphasia*) at the level of the third frontal convolution of the left side. The latter is known as the *convolution of Broca*.

Long before the researches of which we are about to speak were undertaken in foreign countries, the idea of cerebral localizations had taken root and flourished in France. This is the first period of the question, and is entirely clinical and automo-pathological.

The period which follows is at once experimental and clinical. It opened in 1870 with the experiments of two German physicians, Fritsch and Hitzig, followed closely by those of a learned Englishman, Ferrier, and by the clinical application made of them by M. Charcot and his pupils.

The German physicians who opened this period (which may be called one of investigation), MM. Fritsch and Hitzig had observed certain movements in the eyes and head when they submitted a patient to the influence of continuous electrical currents, the poles of the battery being placed one on the right and the other on the left side of the head, behind the ears, upon a bony protuberance called the mastoid process. The movements called forth exhibited certain variations in relation with the direction of the current, and with the opening and closing of the circuit, etc.

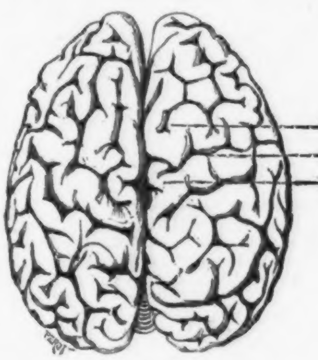


FIG. 1.—MAN.

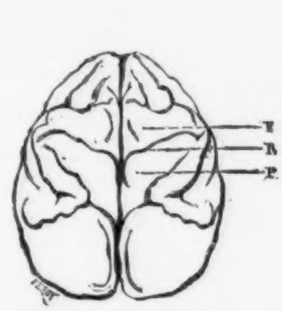


FIG. 2.—MONKEY.

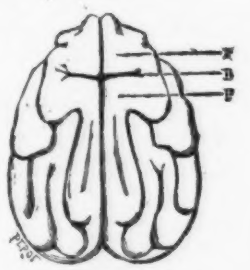


FIG. 3.—DOG.

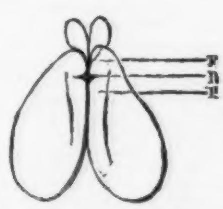


FIG. 4.—RABBIT.

Comparison of the convolutions of the brain in man, the monkey, the dog, and the rabbit. In each figure the letter R corresponds to the fissure which separates the frontal (F) and parietal (P) convolutions, considered as homologous in the series of brains here figured.

Desiring to ascertain the mode of production of these movements, the two experimenters exposed different points of the brain of animals, and applied the poles of the battery systematically to the naked portions of the cortex. They found that galvanic excitations of the brain give rise to localized movements only when they are directed to a circumscribed zone of the frontal region. This excitable zone they designated by the name of "motor," or "psycho-motor zone." Now the cortical points, the excitation of which determines the movements in animals, seems to correspond exactly with those convolutions of the human brain that are called the "ascending frontal" and "ascending parietal." In man these two convolutions are separated from each other by a deep furrow called the *fissure of Rolando;* in the dog they border on an analogous furrow called the *crucial fissure*. The convolution situated in front of the crucial furrow is often called the "anterior marginal," that which bounds it behind being called the "posterior marginal" (analogous to the ascending parietal convolution).

But it might not appear legitimate to form analogies between those points of the cerebral cortex in the dog, the excitation of which produces localized movements on the other side of the body, and those points in the brain of man, the destruction of which carries with it circumscribed paralyses. Although the essential fact was acquired (that of the motor influence of circumscribed regions of the brain), it became necessary to obtain a closer insight into the anatomical conditions which exist in man. This was what Mr. Ferrier did; for he experimented upon monkeys, and confirmed and enlarged upon the conclusions that had been drawn by MM. Hitzig and Fritsch from their researches upon dogs. The English experimenter substituted feeble induction discharges for the galvanic currents that had been previously employed as excitants, the chemical effects of these on the nervous substance being less to be feared. He located with great accuracy in the cortical motor zone of the monkey (which includes, as in man, the convolutions bordering on the fissure of Rolando) a series of circumscribed points, independent of each other, and one of them governing the movements of the fore-paw, another the movements of the hind-paw, another the winking of the eyelids, others, again, the movements of the jaws, tongue, etc. In other words, Mr. Ferrier found it possible to make a true physiological topography of a monkey's brain, and, at the conclusion of his researches, he was able to designate some determinate point of a convolution as the *motor center* of one region or another of the body. The operator could thus announce to those who were present at his experiments that he was about to make the animal raise its right fore-paw, cause it to close one of its eyes, etc.

It may be readily understood what a general interest such results as these awakened. If the experiments upon the dog appeared to some persons not very convincing because of the wide difference which separates this animal from man, the objection, although plausible, must have disappeared in presence of the phenomena established with regard to the monkey, which in all times has been considered as closely allied to man.

But however valuable these experiments were, they could not as yet satisfy the most exacting persons. It was not a question, in fact, of showing solely that there are certain regions on the surface of the brain whose artificial excitation determines movements in the muscles of the opposite side of the body; it was necessary to obtain a clearer insight into the pathological facts observed in man, and to show that the destruction of these cortical motor zones carries with it a paralysis of the muscles of certain regions in the opposite side of the body. This result was obtained by destroying the regions of the brain that had been shown, through excitation, to correspond with ascertained groups of muscles. The paralysis of a superior member thus produced on the monkey was found to be permanent.

Thus experiment had established that there are, in the anterior regions of the brain, determinate points whose excitation gives rise to circumscribed movements, and whose destruction is followed, as in man, by localized paralysis.

While these physiological researches were being pursued in England, French physicians—M. Charcot especially—were grouping together observations on man, and bringing the aid of pathological anatomy to the theory of localizations. Clinical and physiological data seem, then, thus far in accord in allowing us to admit that there are motor localizations in the cerebral cortex. But without pausing for the present over the details of researches, and over the objections that these have raised, let us continue our *exposé* by showing, as far as possible, through what channel these excitations pass in order to cause movements at a distance.

The cortical zones, the excitation of which determines movement, form a cellular covering to the bundles of white fibers situated in the substance of the corresponding hemisphere. Upon removing the gray substance which covers them, excitation has been induced directly upon the white fascicles, and movements have been observed to take place in the same muscular regions which were contracted when the superposed gray substance was excited. This proves that the nervous tubes forming the white substance establish a continuity between the cortex and the organs situated below. But it demonstrates nothing else, as we shall see further on.

On another hand, pathological anatomy has established the fact that the destruction of these white fascicles, by a circumscribed lesion (seat of softening, hemorrhage, etc.), is accompanied by paralyses of greater or less extent according to the importance of the lesion. This being admitted, we may represent, by means of a diagram, the relations of the cortical motor zones, with the subjacent white fascicles. We will thus be better able to perceive how the lesion of the latter can produce the same paralytic phenomena as the restriction of the cortex itself. In figure 5, the points, P and F, represent vertical sections of the cortex of the ascending parietal and frontal convolutions, that is to say, regions which when excited give rise to movement, and whose destruction is followed by a more or less complete paralysis. Beneath this layer, which is composed especially of nervous cells, are seen fascicles of nervous fibers which descend and converge towards a region situated more deeply in the brain (*c r*), and which we will learn to know by the name of the *internal capsule*. These fibers radiating like a fan, the handle of which would be on a level with the internal capsule, and the expanded portion even with the cerebral cortex, have received the name of *corona radians*, or *radiating crown of Reil (cr)*. It is easy to understand that a lesion located in the radiating crown (for example, at the point, *p*), will interrupt the continuity of the nervous fibers, P *p*, and will consequently be equivalent, as far as disorders of movement are concerned, to the destruction of the cortical point, P. If this latter point corresponded to the voluntary movements of an inferior limb, we would observe, as a consequence of the lesion, *p*, a paralysis limited to that member. Let us suppose that the lesion of the white substance, instead of being circumscribed, as in the former instance, extends across the whole fascicle of nervous fibers (A), that are charged with the transmission to the muscles of the whole of one side of the body, of the motor excitations which emanate from the zone, P F, in its entirety; in this case we shall see a paralysis of one half of the body take place, precisely as if the motor zone, P F, itself had been destroyed. Now if we consider that these white fascicles, which serve as conductors to voluntary motor impulses, occupy less and less space as they descend, we shall readily perceive that a destructive lesion of small extent must be accompanied by circumscribed paralytic troubles if it takes place in the spreading portion of the radiating crown; and, on the contrary, produce a total paralysis of one side if it happens in the narrow part of this nervous fan—on a level with the internal capsule, for example. So that a small hemorrhage which takes place in the upper part of the radiating crown will only suppress the movement of a small number of muscles, while a paralysis of one half the body will be the necessary consequence of the same lesion having its seat at the level of the internal capsule.

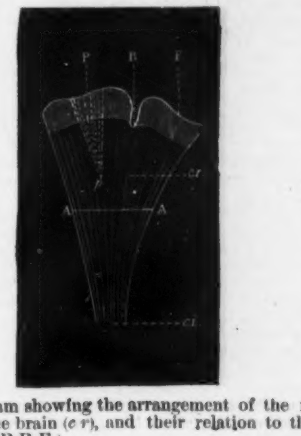


FIG. 5.—Diagram showing the arrangement of the nervous fibres of the brain (*c r*), and their relation to the cortical layer (P R F).

Each one of the motor zones of the cortex, then, is put in communication with the internal parts of the brain by distinct nervous fibers. We must now endeavor to follow these nervous conductors beyond the internal capsule, where we left them.

To start, then, from the internal capsule, the white fibers proceeding from the cerebral cortex become confounded with other fibers furnished by the nervous masses comprised within the substance of each hemisphere, and which are called the *corpus striatum* (S. J., S. E.) and optic layer or *thalamus opticus* (Fig. 6, C O). These united fascicles descend toward the spinal marrow, (M,) becoming more and more condensed, so to speak, and mingling with other systems of nervous fibers, in the midst of which it would be useless to try to follow them. But although the experimenter cannot make a physiological dissection of this kind, it may be effected naturally through the progress of certain lesions; and this phenomenon we must dwell upon for a moment in order to establish its importance.

Anatomo-pathologists have known for a long time that a nervous cord, separated from a center upon which it is functionally dependent, undergoes certain alterations which profoundly modify its structure; and it becomes transformed into a filament more or less reduced in bulk, while its color, normally white, changes to gray. These pathological transformations are known under the name of *degeneration of the nervous tubes*. Owing to the changes of bulk and color which characterize this degeneration, it is possible to follow, even with the naked eye, the passage of altered nervous threads through the midst of those that are healthy; and it is by applying this means of study to the researches under consideration that we have been able to determine with great accuracy the course of the nervous fibers that we had to abandon at the level of the internal capsule—there being no method of physiological investigation that permitted us to follow them further. It has been ascertained that, as a consequent upon accidental lesions affecting the continuity of the white fascicles which are in relation with the

FIG. 6.—Cerebral Peduncle.

motor zones of the brain, the cerebral peduncle (P. C., Fig. 6) corresponding with the injured side exhibited towards its internal edge a grayish band which was found again beneath the ring formed by the protuberance, (Pr), in the rachidian bulb, B. Now this line of altered nervous substance occupies a special cord of the bulb, a longitudinal projection that exists on its anterior face and which is called the *anterior pyramid* (Py, Fig. 6). The fascicles of nervous tubes which we have followed experimentally as far as the internal capsule inclusive, descend then into the corresponding cerebral peduncle, traverse the annular protuberance, and reappear in the anterior pyramid of the rachidian bulb of the same side.

To start from this point, these fascicles pass into the spinal marrow, but form with those which come from the opposite cerebral hemisphere, an almost complete intercrossing. As a result of this intercrossing, our grayish, thin, degenerated band is again found in the left half of the marrow if, in the first place, it occupied the right side of the brain and the bulb. The gray degenerated band descends then into the opposite side of the marrow, and it may be followed in the lateral fascicle for a great distance. It is seen to thin out little by little and terminate in a point in the interior parts of the marrow. For these important facts we are indebted to MM. Ludwig Türk, Vulpian, Bouchard, and Charcot.

Let us briefly recapitulate the essential points which are presented in the preceding study. We shall afterwards be able to show with greater clearness the principal causes of the disagreement that exists at the present day between a certain number of physiologists and physicians, and which characterize the *period* of *discussion* through which we are now passing.

Up to recent years there had been scarcely seen a possibility of locating the voluntary motor faculties in the anterior regions of the brain; and the faculty of articulate speech alone had been assigned to a circumscribed region—the third left frontal convolution (*convolution* of *Broca*).

Beginning with 1870–71, the question of localizations has entered upon an experimental phase, owing to the discoveries of Hitzig, Fritsch, and Ferrier, and the exact observations of Charcot and his pupils. It has been shown that there are in the anterior regions of the brain, at the level of the fronto-parietal convolutions in man and the monkey and in the homologous convolutions of the lower animals, such as the dog, cat, etc., circumscribed points the excitation of which produces localized movements in the muscles of the opposite side of the body, and the destruction of which is followed by a paralysis of these same muscles. These circumscribed regions of the cerebral cortex have received the name of *motor* or *psycho-motor zones*. They have been considered as the point of departure of voluntary movements.

Experiments and clinical observation have demonstrated that these cortical zones were brought into relation with the nervous motor apparatus placed lower down in the spinal marrow through fascicles of nervous tubes serving as conductors to the voluntary motor incitations, and preserving their independence up to their termination in the marrow. The anatomical study of descending nervous degenerations has proved that these nervous fibers descend from the cerebral cortex, forming, in the white mass of the hemispheres, the anterior fascicles of the radiating crown and internal capsule, then an independent cord in the cerebral peduncle of the same side, in the corresponding half of the annular protuberance and rachidian bulb, and that they intercross finally, at the level of the neck of the bulb, with the symmetrical fascicles of the opposite side. From this point of intercrossing, the nervous fibers coming from the motor regions of the cortex of the right side are found then in relation with the motor nerves furnished by the left half of the spinal marrow, and reciprocally. This explains why irritations of the fronto-parietal convolutions of one side give rise to movements of the members of the opposite side, and also why partial destructions of the cortex of one cerebral hemisphere are accompanied by paralyses of the muscles of the opposite side of the body.

Now that we know upon what essential physiological facts the theory of motor localizations rests, we must set forth the objections that have been made to this new conception. This is not the place to open up a discussion which, to be complete, would have to embrace the general questions of the functional nature of the superior nervous centers, their excitability, the influences which modify them, etc., etc.; we will confine ourselves then to a brief *exposé* of the points especially in dispute, without, however, endeavoring to hide the fact of our predilection for the theory of localizations.

The objections may be classed as (1) physiological, and (2) as clinical.

I.—From a physiological point of view the objectors discuss, first, the *functional nature* of the cortical regions whose excitation produces movements in the opposite side of the body. They admit that the cerebral cortex is functionally homogeneous, and that the regions called psycho-motor constitute only points of passage where are grouped the conductors of motor incitations coming from the rest of the cortex, before entering the white mass of the hemispheres; but they compare the zones called psycho-motor to sensitive, impressionable surfaces the irritation of which would give rise, through reflex action, to movements adapted to form a special sensation.

On another hand, certain criticisms, not without value, are bestowed on the experimental processes that are used in calling forth localized movements in animals by excitation of the brain. The electrical irritations would be diffused either over the surface or through the mass. In the first case, the excitation would at the same time reach that one of the cerebral membranes which is sensitive, and from this there would result reflex movements of a painful origin; or, indeed, this excitation would produce a local modification of the circulation, causing the contraction of the vessels which reach the cerebral cortex through its nutritive membrane, the *pia mater*. In the second case, the transmission of excitations through the layer of gray conducting substance would cause movements by irritating the subjacent white fibers, etc.

Each of these objections might be discussed. But in addition to the fact that such a discussion does not enter into our programme, we believe it will be more profitable for our readers if we leave it for a special article at a later period.

II.—The objections of a clinical nature are based on observations that are often borrowed from old authors, and in which the topography of lesions is perhaps not taken into account with sufficient exactness. But taking for our starting point these observations, the value of which is denied by the partisans of cerebral localizations, we must admit as valuable and worthy of being discussed, those well observed facts in which a manifestly circumscribed lesion in the fronto-parietal regions, occupying the whole thickness of the cortex, is not accompanied during life by paralytic phenomena. We do not think that observations of this kind are numerous, while the facts in regard to paralysis of greater or less extent following lesions are constantly multiplying in science.

Such are the essential points of the debate. If some day there is to be an argument, as there is reason to hope, it seems probable that the understanding will take place in the domain of clinics. It is a question of an accumulation of well-observed facts. Discussions that relate to the interpretation of the phenomena produced by the experimental excitation of the motor zones of the brain, and by their destruction in animals, will evidently cease only when the study of the physiology of the nervous system shall be much further advanced; and, in questions that are so complex, progress is slow.

DR. FRANÇOIS-FRANCK.

THE FIRST SILO.

THE opening of the first *Silo*, and the first ensilage, properly so called, ever prepared in New England, took place at the "Winning Farm," Billerica, Wednesday, Dec. 3, 1879. We are thus particular about dates, because the occasion is one which will yet be regarded—if the anticipations of many converts to this new system of harvesting are ever nearly realized—as marking an epoch in American agriculture. Through invitations issued by Mr. John M. Bailey, proprietor of the farm, quite a number of agriculturists from surrounding towns and from Boston were present, together with several gentlemen from New York, who have become interested in this phase of agricultural progress, and had learned of the occasion. There were also on hand one or two representatives of the press.

Mr. Bailey's silos are built on a side hill contiguous to his barn, a portion of the roof of which has been extended to cover them. They are really one building, divided lengthwise into two; are each forty feet long, twelve feet wide, and sixteen feet deep or high, and have together an estimated capacity of 400 tons green fodder. Their walls are fifteen inches thick, the central partition being twelve inches, and are built of "grout"—stones laid in a mortar of three parts sand, four of gravel, and one of Roman cement, "set" by being deposited between plank forms—plastered on the inside faces three inches thick with a stucco of three parts sand to one of cement. The rear vault, which only was used, is largely below the surface of the ground. Nearly two months, parts of August and September, were spent in their construction, twenty five or thirty men being pretty constantly employed during that time, and the total cost was nearly $500.

The crop devoted to the purpose consisted entirely of fodder corn, part "Southern White," and the remainder sugar corn. Six to seven acres were planted, the sowing, which began on the 20th of June, being finished July 1st. The crop, which was cultivated entirely by machine, was hardly an average one. One of the New York Plow Company's large ensilage cutters was used to prepare the fodder for the silo. This cutter was set up against the back wall of the silo, which is here not very high. The corn was put through this machine immediately on being cut from the root, was minced into pieces of a uniform length of three-tenths of an inch, and thrown over the wall into the silo, where men were employed in stowing and tramping it thoroughly down. The machine was up to the mark in the quality of its work, but fell short as to the quantity. The harvesting occupied the last ten days of September, and the corn being now all packed in the silo, it was carefully closed, a thick layer of rye straw being laid on top, then two courses of boards, lengthwise and crosswise, upon which were placed loose stones, in quantity a thousand pounds to the square yard. Care was taken that this platform should move free and clear within the silo, as it serves the purpose of a *piston* to compress, as well as a lid to cover. This work being completed, the silo, which was now about two thirds full, and contained upward of a hundred tons of "fodder," was left undisturbed till the day of opening.

Much the same trepidation was betrayed by several of the spectators, while the coverings were being removed, as is said to be manifested by the friends of some unfortunate well digger who is being exhumed from beneath a number of cubic feet of treacherous greedy mould. When the ensilage was finally reached, its good color, barring the inch or two of spoiled stuff which was to be expected, at the top, was quite encouraging. Considerable heat was noticed in this portion, however, and the odor of acetic fermentation was quite palpable. Further digging into the mass confirmed these unpleasant indications. The ensilage, although not at all offensive to smell or taste, and mainly of good color, had become entirely sour. The liquid or juice with which it was charged had the taste of vinegar, while the slices tasted like pickles, and the whole had somewhat the smell of beer—as your correspondent imagines the aroma of that beverage. As ensilaged green fodder is supposed to come out almost the same as it went in, in all respects, and entirely the same as regards sweetness and flavor, the condition of this was a great disappointment.

Several large baskets, however, were speedily hoisted out and placed before the cattle. Here the result began to appear much more encouraging, as the majority took hold of it with avidity. Some rejected it altogether, however, and none seemed inclined to consume a large quantity. It was offered to the horses and sheep, also, with about the same results—some seemed to like it and others refused it. The more experienced farmers present agreed, however, that all would probably soon learn to like a portion. What the exact value of such fodder would be, however, no one seemed inclined to estimate, or what its effect on the health of animals. It was generally argued that, fed with hay, bran, etc., good results should be expected. Mr. Bailey, the proprietor, who has made a thorough study of Goffart's book, and other things bearing on the subject of ensilage, could give no reason for the souring of his fodder, while Mr. Brown, of the New York Plow Company, who was present, and who is *the* authority on the question in America, was as completely at fault. Certain facts were stated which may lead to the true explanation, as, for instance, that there was a slight frost, turning some of the leaves, a day or two before the harvesting was complete; that a previous drought had dried up some of the leaves; that a giving out of the machinery had caused some considerable delay and extra exposure of the ensilage; that a slight springing of one or two of the walls may have caused cracking and admitted the air, etc., etc., while it was conjectured that the corn may have been too mature. None of these explanations were received as final, however, by anybody. As to the result of the experiment, it cannot be considered a failure until it is demonstrated that the fodder now stored up will spoil, or that cattle will not or cannot eat it. The indications now are that it *will not* spoil, and that cattle will and can eat it—and hence that it will prove a success—qualified, of course, but still a success. But let this be as it may, Mr. Bailey certainly deserves great credit for the public spirit and enterprise displayed by him in making so faithful and costly an experiment, in a direction so valuable and necessary to the community.

REMARKS.—Since the above was written by our reporter, we have received a note from Mr. Bailey, in which he says: "At the second feeding all my cattle ate the ensilage with avidity, and, upon exposing it to the atmosphere several hours, a strong alcoholic odor is perceived and the acidity is much lessened. I believe its preservation is perfect, and that the first silo in America is a perfect success. . . . My cattle now eat the ensilage as readily as they do the beet pulp from the beet sugar factory at Portland."—*N. E. Farmer.*

PRESERVING APPLES.—A correspondent of the *Rural New Yorker* writes that he has tested the method suggested in agricultural papers, of keeping apples the year round by wrapping them in paper, for two successive years, and finds it to be a perfect success. The plan pursued was to take old newspapers, cut them into pieces of sufficient size, and wrap each apple by itself and pack them away carefully in barrels or boxes, so as to exclude the air. The variety selected was the Northern Spy, and last year, as late as the 14th of August, they were still fresh and crisp, and he had no doubt they might have been kept much longer, had not the temptation to eat them been so strong.

LUCERN.

THIS is a grass which is a native of California, and is also called Alfalfa, and Mexican or Chili clover. It was brought to Utah some six or eight years ago, and has proved a wonderful blessing to people of small means, and a continued source of profit to farmers. It grows to the height of about 2½ feet, and should be cut when in bloom, otherwise the stalks become too large, tough, and woody. It cuts two crops the first year after sowing, and three and four crops in succeeding years; the seed never running out, but on the contrary, growing firmer and spreading yearly, and the roots stretching down for water, often, in fact, reaching the depth of forty feet. The yield is from two to three tons per acre, each cutting, the first of which is about June 1st, and the succeeding one coming in about six weeks, and so on with the remainder, until the close of the season, which ends here (Utah) from Sept. 1st to Oct. 1st, according to the weather.

There seems to be quite a diversity of opinion between farmers and livery stable keepers as to its usefulness. The former universally commend it in the highest terms, saying that horses will do better on it than they will on hay and grain combined; but the latter speak disparagingly of it and do not use it. This is very easily explained from the fact that their horses are driven by people who have no interest in them, and, consequently nothing but grain will give them the bottom required, while lucern, under a severe treatment, is slightly laxative.

In desert lands it is irrigated about once a month; but one crop can often be obtained without water. To describe it, so that your readers will understand it, I would compare it to a rank growth of clover, although the flower is blue, making it, when in bloom, look like a field of flax. Poultry, hogs, and horned stock thrive on it, the latter preferring the leaves, while horses prefer the stalks, and are quite unwilling to eat the cows' first choice. The seed costs about fifteen cents per pound, and the hay sells for from eight to ten dollars per ton.

If used as a soiling crop, it must, at first, be fed very carefully, until the stock become used to it, otherwise it bloats them. It seems adapted to a dry, deep soil and a dry climate, and is planted in the spring or fall, like grain, but no cereal must ever be sowed with it. Twelve pounds of seed to the acre should be used.

From my knowledge of Massachusetts lands, I should say that it would be a very successful crop on the very dry lands, but meadows on moist ground would cause it to mildew. The farthest east, to my knowledge, that it is now grown is Missouri, where I learn it has proved a successful and paying production. Brigham Young, recognizing its great benefit to Utah, renamed one of his sons "Alfalfa," who, true to the civilizing influences of the origin of his name, has cut loose from the Mormon church.—*Ranchero, in New England Farmer.*

OUR COTTON CROP FOR 1879.

THE whole country is interested in cotton. Before the insurrection, when cotton was king and our people purchased most of our textiles, iron and steel from Europe, it formed our chief remittance, and now, after breadstuffs and provisions have become our principal export to Europe, it still remains a leading article in our exports. Since the war our crop of cotton has gradually increased. Free labor has come in to supply the place of the involuntary labor of the slaves. Last year we gathered 5,073,531 bales, averaging about 470 pounds to the bale. The crop exceeded the great crop of 1859, and was the largest ever raised in this country. Of late years the consumption of cotton in England has been checked by trade unions and the rivalry of America and the continent of Europe. During the past year the consumption has been 1,125,000,000 of pounds in the British Isles and 1,025,000,000 of pounds on the continent. To eke out a small supply of cotton, England has adopted short time and closed many of her mills, but such has been the growth of the manufacture on the two continents of the Old World and the New, that the stock was nearly exhausted both at home and abroad, and merely sufficed to keep the mills in operation that had not closed their doors until the new crop was gathered. The visible supply of cotton, which includes all in store or afloat, was, at the close of August last, reduced to seven weeks' stock in place of a stock in former years sufficient for six months' supply.

Since 1876 the reduction of stock has seriously alarmed the weavers and spinners of England. The visible supply of cotton in store or afloat has been as follows:

	Bales.
On Sept. 1, 1879	943,179
" 1, 1878	1,115,485
" 1, 1876	1,785,613

While the wants of the world increase from year to year, the stocks of the world have been steadily decreasing. The Messrs. Ellison, high authorities in England on the subject of cotton, have from year to year predicted increased shipments from India, but less and less has come, and the shipments have been kept down by undue depression of prices

both at home and abroad. And now we come to the results.

First, a diminution of the visible supply of cotton exceeding that of the previous year by 200,000 bales; an increase of the consumption of cotton on the two continents of 200,000 bales more, and an increase of at least 150,000 bales more in the requirements of England and a similar increase in the United States.

By the estimates of our department of agriculture, and according to the opinion of our experts, we may expect in this year of activity the consumption in this country of an increased quantity of cotton, to the extent of 200,000 bales. Thus the world requires at least 750,000 bales more than it used last year. Egypt may send a little more than it did last year, when the Nile would not overflow its banks. India, the customary resort of English speculators to fill up a gap in their estimates, has little to spare and no incentives to increase her crops from the recent low prices of cotton. Her soil, too, will not make in cotton one half the return which is made in America. This year the merchants of India will employ half the steamships that visit her shores to the conveyance of wheat to England She will probably dispatch this year to England half a million tons of wheat and but very little cotton from the alluvial plains at the sources of the Indus and the Ganges. There will still remain a deficiency of more than 600,000 bales of cotton, if we deduct from the stock now visible, which is 943,179 bales, the residue of 343,179 bales, which is less than a fortnight's supply, will be all we have left at the close of August, unless some of the mills are arrested. To say that the visible supply has increased a little since the 1st of September is not a sufficient answer to our position. The less amount exhibited last year, in August, September, and October, was due to the fearful fever which kept back the receipts of cotton at New Orleans and Mobile to the extent of 275,000 bales. This year the void has been filled, the shipments have reached the two great seaports of the South, and there is apparently nothing to prevent the absorption of most of the stock before the close of August and an attendant rise of prices; already a corner has been made in Liverpool, and the price advanced to seven pence per pound, but it must rise above this price before it can bring any relief from India. For a series of years the price of cotton has been quite inadequate to remunerate a cultivator either in India or our Southern States. The East Indian ryot gets but eighty-nine pounds of cotton, on the average, from an acre of land, less than half the customary return in this country. The staple, too, of the East India cotton is inferior to our own; and this cotton must be carried for hundreds of miles on the backs of bullocks to reach a railway. And in our Southern States the freedmen get on the average but $11 a month, with inferior rations, for their services, receiving as they do the lowest wages paid in the United States. The manufacturer will not suffer should cotton rise in this country to $65 per bale; in such case the improved price would add materially to the value of our exports and carry up cotton shipped from our ports from a valuation of $180,000,000 above $210 000,000. If our countrymen are wise, they can, this year, obtain remunerative prices from Europe for both cotton and breadstuffs; and if such prices should induce India to send additional wheat or cotton to Europe she would cheerfully accept in payment the tons of silver which are accumulating in our Sub-Treasury, which she needs, but is unable to purchase.—*Economist.*

A CYLINDER OF CYRUS THE GREAT.

SIR HENRY C. RAWLINSON lately read an important paper before the Royal Asiatic Society on "A Newly-discovered Cylinder of Cyrus the Great," which he described as the most interesting historical record in the cuneiform character as yet brought to light. It was not among the monuments lately brought home by Mr. Hormuzd Rassam himself, but must be credited to his last archæological explorations in the East, under the auspices of the British Museum, having been sent to this country by one of the agents left behind by him to continue his excavations in the Mesopotamian mounds. It is in the Babylonian script, as was to have been expected from its having been discovered among the ruins of the Birs Nimroud, the acknowledged site of the ancient Borsippa, of which city, as Sir Henry Rawlinson remarked, it was the more surprising that it makes no mention. The cylinder is 9 inches long by 3¼ inches in diameter, and must originally have been covered with forty-five long lines of text. The writing is very minute, and it is computed that the inscription would run to about 130 lines of the average length. Unfortunately, the monument is very badly injured, and the beginning is wholly lost, with the exception of a few scattered signs. When it does begin to be legible it is found to relate to the very moment of that great historical event, the capture of Babylon by the founder of the Persian Universal Monarchy. Nabonidus has abandoned his capital, which has fallen into the hands of Cyrus, though he is still struggling against his fate in Babylonia. But the priestly worshipers of the rising sun declare that the gods have rejected him for his impiety and for his scandalous neglect of their temples. On the other hand, they extol the piety and the greatness and glory of Cyrus, whom the heavenly powers have raised up to avenge their cause. The Guti, whose overthrow Sir Henry Rawlinson thinks was involved in that of the Medes, and a people whose name is taken to be equivalent to Blackheads, reminding us of the negroes, are described as his subjects, and the god Merodach has delivered King Nabonidus into his hands. Of Belshazzar no mention is discoverable, although it is conceivable that this may be due to the many and serious gaps in the inscription. The long introduction is followed by what purports to be the text of a proclamation issued by Cyrus upon the taking of the city, and in which the King repeats in the first person the principal allegations of the preamble. It is partly mutilated, but the beginning, "I am Cyrus," with his genealogy in full, and his description of himself as "King of Gyndia," etc., can be pretty clearly made out, and Sir Henry gave a translation of all that is legible. Cyrus is made to speak of his reparation of the temples of Babylon, and of the favors conferred upon him by Merodach, Bel, and Nebo in answer to his prayers to them, of the homage paid him by distant nations, and of the gatherings of the people in the city to acclaim him king. The last ten lines are illegible. Sir Henry Rawlinson said this new text settled for ever, in favor of Herodotus as against Ctesias (in Diodorus), the genealogy of Cyrus. He was fifth in descent from Achæmenes, next to whom came Teispes, Cyrus, then the grandfather, and Cambyses, the father of Cyrus the Great. Moreover, the succession was direct, not indirect, as Professor Oppert had maintained. The inscription styles the native country of the Persians "Assan," which Sir Henry Rawlinson gave reasons for locating in the plains between the modern Shuster and the Persis of the classical writers. He gave an interesting account of the great temples of Babylon. An important religious center named Calana in the inscription he illustrated by reference to the Calneh of Genesis and the Calno of Isaiah. The great difficulty, he said, in the inscription was the transformation of the royal zealot of Aurumazda into a devotee of the Babylonian gods.—*Building News.*

FIGURES OF SESOSTRIS.

MR. F. W. FURNIVAL, writing to the London *Athenæum* from Smyrna, says: "I shall be glad if you will allow me to inform archæologists in England of a very important discovery which has been made in this neighborhood. It will be remembered that in his second book Herodotus speaks of two figures of Sesostris carved on rocks in Asia Minor. One of these is well known, and is commonly called the Pseudo-Sesostris. It is sculptured in low relief on a rock in the pass of Carabel, near Nymphi, and represents a man with a conical head-dress and boots turned up at the toes, holding in his right hand a bow, and in his left a spear. Herodotus, so far as I remember, describes one of the two figures, and speaks of it as having the spear in the right hand and the bow in the left; he also states that there was an inscription in sacred Egyptian characters running across the breast, whereas the only characters on the Pseudo-Sesostris are near the head of the spear. Hence it has generally been supposed that the historian's account is inaccurate; but I am now able to inform your readers that the second figure has been discovered, and that it exactly answers to his description. It was found about eighteen months ago by Mr. Spiegenthal, the Swedish Vice-Consul at Smyrna, who kindly furnished me with particulars which enabled me to see it last week. It is sculptured on a piece of rock near the entrance to the pass of Carabel, and at a short distance from the Pseudo-Sesostris, to which it bears a general resemblance; but there are several reasons which lead me to believe that it is the figure which Herodotus describes. In the first place, the spear is held in the right hand and the bow in the left, as he distinctly asserts; and, moreover, there are traces of a belt running across the breast on which characters may have been inscribed, while there are no signs of them near the head of the spear. Again, it is probable that Herodotus would describe the second figure if he visited the spot, as the old road, which can be clearly traced, passed close by it, while the first figure, by which I mean the Pseudo-Sesostris, stands about 120 feet above it, and could not be seen so easily. Owing to its position near the road, the second figure has not been so well preserved as the first, and no characters of any kind can be distinguished; but those on the first figure are still legible, and Professor Sayce, who accompanied me, considers them to be Hittite. The road through the pass of Carabel now runs at the back of the rock on which the second figure is sculptured, and on this account it has not been seen by former travelers. I may add that when we visited the statue of Niobe, on Mount Sipylus, we heard of a rock-cut figure near it, representing some kind of animal, and apparently of a very archaic character. Unfortunately we were unable to find it; but we discovered ancient remains of various kinds, including several rock-tombs; and the fact that these and the second figure of Sesostris have been so long unknown shows clearly enough how much is left for archæologists to do in this part of Asia Minor."

AN ENORMOUS EEL.

MR. MILESTONE, fishmonger, of 6 Swallow place, Regent street, London, was kind enough to let me know that he had received, Nov. 22 last, an enormous conger, the weight of which was 128 lb., its total length being 8 ft. 3 in., and the girth 25 in. It is a matter of much regret that I was too late to see or cast this monster. Before I arrived at Mr. Milestone's it had been sent away to the lunatic asylum at Caterham. In the appendix to the Sea Fishery Report, which has just been published, I have given the weights of the largest congers that have come under my notice. In 1878 Mr. Jackson, of Southport, sent me a conger 69 lb. weight, 6 ft. 5 in. in length, and 2 ft. 5 in. in girth. Mr. Dunn, of Mevagissey, informs me that the largest conger ever taken at Mevagissey was caught by Maxwell Dunn and James Hicks, and weighed 112 lb. On the same night that they caught this extraordinary fish these fishermen caught another of 70 lb. and another over 60 lb. I heard of a large conger being landed at Falmouth whose length was 7 ft. 4 in.; girth, 2 ft.; and weight, 72 lb. In November, 1868, I received from Folkestone a conger which measured 6 ft. 4 in., and weighed 50 lb. A cast is now in my museum. There are also casts in the museum of a conger from the Lower Shannon, which measured 6 ft. 9 in.; girth, 20 in. Congers are exceedingly sensitive to frost, and I know at least two cases when congers have been reported as floating half dead on the surface of the sea in the condition which fishermen call "blown;" that is, the air bladders get so distended they cannot get beneath the surface of the water.

Congers are fish which like warm water. They are found in Cornwall, Devonshire, Jersey and Guernsey, in Ireland, and in parts of France washed by the Gulf Stream. They are also found in considerable numbers among the great chalk rocks at the bottom of the sea in the neighborhood of Dover; probably also in the Channel, right across to Boulogne, as I have seen some huge congers in the Boulogne market. These were destined for the Paris markets, where, no doubt, the French cooks formed them into "stock" for all sorts of dishes. The congers are very voracious fish. The power of the jaws is tremendous. They will eat almost any kind of fish, and are specially fond of crabs and lobsters. In the Sea Fisheries Report I have given tables showing the food of sea fish, and the various substances found in the stomachs of congers may be thus enumerated—pilchards, dabs, soles, plaice, weevers, mackerel, herrings, etc. The best bait to catch them is cuttle-fish. Now that the cold weather has come we shall not, I think, see many congers about, as they retire into very deep water and there remain in a semi-state of torpidity till the warm weather comes. The best time for congers is from March to October. The congers carry an enormous number of eggs Mr. Jackson made out that his large conger contained between fourteen and fifteen million eggs. What becomes of this enormous number of eggs is unknown to mortal man. They probably form the food of many small sea creatures, especially crabs. The eggs of the conger are exceedingly minute, and very like the eggs of the fresh-water eel, which are known to most persons as the fat of the eel The freshwater eels are all down to the sea by now. The eggs will hatch out in the estuary, and the young elvers will be coming up the rivers the first warm weather of 1880. There is a belief among some that freshwater eels going to the sea are turned into congers, but this is impossible, as the conger is a distinct species from the freshwater eel. What becomes of the parent freshwater eels which go down in October and November to spawn, nobody knows. My own belief is that they return up the river again, but are not observed doing so, because they come back singly; whereas, when going down, they go in great shoals and are caught in large numbers, especially at Gloucester and Worcester, where enormous nets are used for this purpose. I do not hear of the eels descending the Thames being caught at the various weirs in the Thames. I really do not see why they should not be caught, and the proceeds applied to the preservation of the river under the direction of the Thames Angling Preservation Society. I should like Mr. Speckly and Mr. Brougham to pay attention to this point. Eels just at this time of year are sadly wanted for the stewed-eel shops, establishments which provide the poor of London with excellent and cheap food, admirably suited for the cold weather, in the form of stewed eels. Most of these now come from Holland. The Dutch skoots which bring them can always be seen anchored off Billingsgate Market. The reason why these skoots are always in this particular place is that Queen Elizabeth gave a free right of anchorage at this spot for Dutch vessels, and I believe they are now moored to the very same stone which was sunk in this spot in the days of Queen Elizabeth. In all engravings of London since her time you will find these skoots in their proper place. We have unfortunately as yet no proper returns of the quantity of fish brought into Billingsgate Market, but Mayhew, in his "London Labor and London Poor," informs us that in 1864 there were sold from Holland, England, and Ireland over nine millions of eels; of these, in weight, 1,000,505 lb. came from Holland, 127,000 lb. from England and Ireland, none from Scotland. It is perfectly incomprehensible to me why the Scotch lessees of fisheries will not catch the eels. I don't want them to eat the eels, because I know they will not do so, but surely they will sell them and get a check back from Billingsgate in a few hours, yet they will not catch these eels.

In former times eels were thought of considerable importance, as I find that there were statutes enacted concerning how they were to be packed and imported in barrels. These statutes are the 22d of Edward IV., cap. 2; 2d of Henry VII., cap. 23; 5th of Elizabeth, cap. 5; 32d of Charles II., cap. 2, sec. 7; 10 and 11 of William III., cap. 24. I shall feel much obliged to our legal correspondents if they will kindly look up these passages and let us know what are the laws relating to eels which our forefathers thought it expedient to enact.—*Frank Buckland, in Land and Water.*

ECCENTRICITIES OF BIRDS.

WE are seldom discomposed by the song of birds; but all such music, however, is not composing. We are pleased with the song of the whip-poor-will, especially if no more than two or three are heard at the same time and are far apart. This measured music is pleasant partly on account of its formality, and yet for this reason they fix our attention. A song is not necessary to make the voice of a bird pleasant. Take the chickadee—his note is agreeable, though not measured or continuous; the call note of this bird is very animated, from which it gets the name. Chickadee-dee-dee is always uttered, at irregular intervals of two or three minutes, by each bird. This bird does not forage in compact flocks, like sparrows and other granivorous birds, whose food, consisting of the seeds of grasses, is distributed over almost every field. The food of the chickadee, being of insects and their eggs and chrysalids, which are lodged upon the wood and bark of trees, is not abundant at any one place, and has to be obtained by diligent search; they are compelled, therefore, to scatter, like the woodpeckers, because their food is scattered. Woodpeckers are much less noisy than the chickadee; they have not so many notes of greeting as the latter; their hammering upon trees appears to answer a similar purpose. Nature appears to bestow on birds and animals only just such an amount of language as their wants require.

The downy woodpecker is almost always found associated with the chickadee; he is distinguished by his speckled plumage, his scarlet crown, and his sudden and rapid flight. This small bird appears, as it were, a companion of the chickadee. In the season of winter, birds of like habits have a general inclination to associate, for mutual protection; they seem to be cheered by hearing the voices of others around them. The small woodpeckers, the creepers, and the chickadees have a sort of affinity; they keep within hearing of each other from a social feeling, of which they probably have no less than the gregarious species.

A singular habit of the downy woodpecker, and one with which all are familiar, is that which has gained him the name "sap-sucker." He bores little holes just through the bark of the tree, usually an apple tree, not penetrating into the wood. These holes form a complete circle round the branch of the tree, about half an inch apart. No theory has yet been advanced that satisfactorily explains the object of the bird in making these perforations. The theory that they are made for the purpose of sap-sucking is perhaps the most plausible one. Admitting this theory, the cause of their arrangement in a circle is still unexplained. Farmers were formerly disposed to consider these sap-suckers injurious to the health of trees, but observations have proved their harmlessness.

The gregarious habits of certain species of birds, and the more solitary habits of others, are the necessary consequence of their different ways of feeding. The insect-eaters among land-birds are seldom associated in flocks; but they are fond of company, and do not like to be alone. The granivorous birds, on the contrary, with a few exceptions, are gregarious. Such are the English sparrow and buntings—compare, in this respect, the common robin and the red-winged blackbird. The robin is exclusively insectivorous; the fruit he consumes is not his subsistence, and he swallows no kinds of seeds. The redwing, on the contrary, is omnivorous, and is a great consumer of every kind of grain. Hence, robins are never seen in large or compact flocks. The cause of this difference in their habits is that robins, on account of their exclusive diet of grubs and insects, are obliged to forage singly; while blackbirds, who are voracious of every eatable substance that lies upon the ground, sometimes glean a whole field by going in companies. All seed-eaters do not assemble in compact flocks. The goldfinch, or this le bird, and nearly all the finches are examples. Goldfinches are choice and dainty in their food, they peck the seed directly from the plant that bears them, and take off the shells before they swallow the kernels. The goldfinch hunts for his cereal food in the same way as the chickadee hunts for his grubs and insects. The goldfinch is not an inveterate singer—he is seldom heard to finish a tune—he does not devote his whole time to song—nor is he like the red thrush, sitting for half an hour on the same branch singing without cessation. One peculiar habit of this yellow bird (goldfinch) is that the male bird, after building a nest,

will peck it to pieces and build another nest with the same material in its vicinity. The first nest is not occupied in any instance, and the second one sometimes remained vacant.

It appears to be the received opinion that the song of a bird is a disinterested effort on the part of the male to comfort his mate while sitting on her nest. The song certainly produces the desired effect, but this does not appear to be the motive of the songster. It is, on the contrary, an outpouring of his impatience, on account of her absence, and an effort on his part to call some other female to join him. Though the male bird often takes his turn upon the nest during incubation, he is impatient while thus employed, and spends only a small part of his time in the discharge of this duty. Even in procuring food for the young birds, he is not as diligent as his mate; watch a pair of robins when they have a brood of young to feed, and it will be seen the female provides the greater part of their food; watch also a mated pair in a common flock of pigeons, while the female is employed in her maternal duties, her lonesome partner resumes the same loud cooing that was heard when he was choosing his mate. The delight which he always shows, when some unmated female responds to his calls, is very evident. He must therefore be pronounced a great flirt.

There appears to be a purpose in the cries of birds, as well as of other animals; the cackling of a hen always disturbs the male bird, the drumming of a pheasant excites the wrath of every male of his own species and frequently ends in a fight. Birds, when captured, generally utter similar cries, and courageous animals make a louder noise when seized than those of a timid species. The pig, in its wild state, is very courageous; when one of a herd is in danger, the whole herd will run to its protection. Sheep, on the contrary, when one of their number is attacked, do not turn to protect it, but run away; the captured one only moans, but makes no loud cries.

Birds in general are more determined in defending one of their number, when captured, than quadrupeds, and are therefore more vociferous when they fall into the hands of an enemy. It may, therefore, be said that the courage of any species of animals, at least of those which are gregarious, may be estimated as in a direct ratio to the noise they make when captured.—(*Flagg.*)

The introduction of the English sparrow into this country is much to be regretted; their presence is assuredly a bar to the multiplication of the several admired and important species of native small birds. This is the opinion of those who have had the best opportunities of judging. The sparrows allow the smaller birds no peace, and will eventually drive them all away from parks, gardens, and roadsides. To save the native house birds from their encroachments, small boxes should be constructed in such a way as to exclude the sparrows; to protect wrens and swallows, the holes should be made of just such dimensions as to admit these small birds, so that the sparrows, which are larger, cannot enter them.—*Henrico, in Virginia Agricultural Journal.*

ARTIFICIAL FERTILIZATION OF OYSTER EGGS.

IN his Notes from the Biological Laboratory of the Johns Hopkins University, given in the *American Journal of Science*, Prof. W. K. Brooks remarks:

All the writers upon the development of the oyster, from Home (Phil. Trans., 1827), to Möbius (Austern und Austernwirthschaft, 1877), state that the eggs are fertilized inside the shell of the parent, and that the young are carried inside the mantle cavity until they are provided with shells of their own; that they leave the parent in a somewhat advanced state of development, and that their free-swimming life is of short duration and lasts only until they find a suitable place to attach themselves.

Misled by these statements, which do not apply to our species, I opened a number of oysters during the summer of 1878, and examined the gills and the contents of the mantle-chambers for young, but found none, and concluded that the time during which the young are carried by the parent must be so short that I had missed it. I undertook the same investigation this May, with the determination to examine adult oysters for young every day during the breeding season, and at the same time to try to raise young for myself by the artificial fertilization of eggs taken from the ovaries. I had complete success with the second method from the first, and succeeded in raising countless millions of young oysters, and in tracing them through all their stages of development up to the time when they had acquired all the characteristics which Salensky, Lacaze Duthiers, Möbius and others have figured and described in the young European oyster at the time it leaves its parent. I also made careful examination of the gills and mantles of more than a thousand oysters, but never found a single fertilized egg or embryo inside the mantle-cavity of an adult, although I found females with the ovaries full of ripe eggs, others with the ovaries half empty, others with them almost entirely empty, and others at all the intermediate stages, and I therefore feel sure that my examinations were made upon spawning oysters.

While this evidence is for only one season and one bed, I think that until it is shown to be exceptional, we must conclude that there is an important difference in the breeding habits of American and European oysters, and that the eggs of the American oyster are fertilized outside the body of the parent; that during the period which the European oyster passes inside the mantle-cavity of the parent, the young American oyster swims at large in the open ocean.

The more important points in the development of the oyster are:

1. The oyster is practically unisexual, since at the breeding season each individual contains either eggs or spermatozoa exclusively.

2. Segmentation takes place very rapidly and follows substantially the course described for other Lamellibranchs by Lovén and Flemming.

3. Segmentation is completed in about two hours, and gives rise to a gastrula, with ectoderm, endoderm, digestive cavity, and blastopore, and a circlet of cilia or velum. At this stage of development the embryos crowd to the surface of the water and form a dense layer less than a quarter of an inch thick.

4. The blastopore closes up; the endoderm separates entirely from the ectoderm, and the two valves of the shell are formed, separate from each other, at the edges of the furrow formed by the closure of the blastopore.

5. The digestive cavity enlarges, and becomes ciliated, and the mouth pushes in as an invagination of the ectoderm at a point directly opposite that which the blastopore had occupied. The anus makes its appearance close to the mouth.

6. The embryos scatter to various depths, and swim by the action of the cilia of the velum. The shells grow down over the digestive tract and velum, and the embryo assumes a form so similar to various marine lamellibranch embryos which are captured by the dip net at the surface of the ocean that it is not possible to identify them as oysters without tracing them from the egg. The oldest ones which I succeeded in raising in aquaria were almost exactly like the embryos of Cardium, figured by Lovén.

7. The ovaries of oysters less than one and a half inches in length, and probably not more than one year old, were fertilized with semen from males of the same size, and developed normally.

An illustrated paper on the embryology of the oyster, with a detailed account of my observations, will be published, shortly, in the report of the Maryland Fish Commission for 1879.

BALTIMORE, Nov. 5, 1879.

THE COSMOGONY OF LAPLACE.

By DANIEL KIRKWOOD, LL.D., Bloomington, Indiana.

[Read before the American Philosophical Society, Sept. 19, 1879.]

LAPLACE'S celebrated nebular hypothesis was first distinctly stated in his "Système du Monde."* The reasoning by which it is there sustained is general, and it does not appear that the author made any effort to test his theory by analysis. The law of the conservation of energy was then undiscovered, and hence data, which now seem available for a critical examination, were entirely wanting. Let us consider the hypothesis in some of its obvious aspects.

1. It is assumed by Laplace that nebulous rings were abandoned only in the vicinity of the present orbits of the planets. While I have for many years believed that the matter of the solar system originally existed in a gaseous condition, and hence that *a* nebular hypothesis in *some* form must furnish the true explanation of the planetary motions, I have more than once ventured the opinion that this assumption of Laplace is wholly unwarranted. I make a single quotation from the Monthly Notices of the Royal Astronomical Society for January, 1869:

"The known facts in regard to the zone of minor planets, as well as the phenomena of Saturn's rings, seem to demand a modification of the nebular hypothesis as generally held. No reason has ever been assigned why the solar nebula should not have abandoned rings at distances intermediate between the present orbits of the planets. On the contrary, it seems highly probable that, after first reaching the point at which gravity was counterbalanced by the centrifugal force arising from the rotation of the contracting spheroid, a continuous succession of narrow rings would be thrown off in close proximity to each other, and revolving in different periods according to Kepler's third law."

The view thus expressed in 1868 has never been called in question, and I have seen no reason to modify it. The *ring* theory thus seems to require that after matter began to be thrown off at the equator of the revolving mass, the process should have been almost continuous until the nebula became transformed into a close system of rings presenting the appearance of a thin plate or disk. The theory would thus fail to account for the formation of the solar system as it actually exists.

2. But even if we adopt Laplace's theory of ring formation, we at once encounter difficulties no less serious. It is obvious, on the slightest examination, that the mutual attraction of different portions of a zone could have very little influence in bringing its molecules together around a common nucleus. Laplace, it is true, supposed the fragments of a ring to have been thus collected into a single planet. "Almost always," he says, "each ring of vapors ought to be divided into several masses, which, being moved with velocities that differ little from each other, should continue to revolve at the same distance from the sun. These masses should assume a spheroidal form, with a rotary motion in the direction of that of their revolution, because their inferior particles have a less real velocity than the superior; they have, therefore, constituted so many planets in a state of vapor. But if one of them was sufficiently powerful to unite successively by its attraction all the others about its center, the ring of vapors would be changed into one sole spheroidal mass, circulating about the sun, with a motion of rotation in the same direction with that of revolution."

In regard to the mutual attraction here referred to, it may be remarked, that two parts of the Neptunian ring on opposite sides of the sun could produce no sensible perturbation of each other's motion. If, moreover, the fragments of any ring were distributed around the orbit with approximate uniformity, their mutually disturbing effects would nearly destroy each other. That this state of things should have obtained in the case of some of the eight principal planets is extremely probable. The theory, therefore, of planetary aggregation by the attraction between different parts of the rings, requires an indefinite antiquity of the solar system. Let us suppose, then, that the planet-forming process was due to the different velocities of the fragments into which a ring had been broken up. Take, for example, the ring which was transformed into Neptune. Let us assume that two fragments, A and B, differed in longitude by 180°, and that the mean distance of the center of gravity of A from the sun's center exceeded that of B by 1,000 miles. It is then easy to show that the corresponding difference of their angular velocities would not bring them together around the same nucleus in 150 millions of years. But even after *all* the fragments had thus been collected, other millions of years—assuming with Laplace that the united mass was still in the gaseous form—would be required for the process of condensation. The supposition we have made is not an extravagant one. In Laplace's cosmogony, therefore, hundreds of millions of years are involved in the separate history of a single planet. Is so great an implied age of the solar system admissible?

According to Helmholtz, whose theory is now generally accepted, the sun's heat is but the transformed motion of its parts condensed or drawn together by the force of gravitation. Now, the law of the conservation of energy enables us to calculate the age of the sun, knowing (1) the amount of solar heat radiated in a given time, and (2) the amount produced by a given contraction of the sun's mass. It has thus been found that condensation from the distance of the nearest fixed stars to the sun's present volume, would have kept up a supply of heat equal to the present for about twenty millions of years. This estimate, it will be understood, is based on the assumption that the sun's density is uniform from center to surface. If, as is altogether probable, the density increases toward the center, the age of the sun may be considerably greater.†

3. The difficulty here presented is one of no small importance. If removed, however, we are immediately met by another perhaps still more formidable. Assuming the decrease of Neptune's radius to have been uniform during the time required for the accumulation of the ring around a single nucleus, the daily superficial deposit would be less than one-sixtieth of an inch; the density being equal to the present density of the planet. This extremely slow transformation of the nebulous zones would develop little heat; so that the planets would be nearly cold during the process of their formation. Laplace's theory, therefore, obviously fails to account for the origin of satellites.

4. It is easy to show that the period of a rotating nebula in the process of condensation would vary as the square of the radius. If the solar nebula, therefore, rotated once in 164·6 years, when it filled the orbit of Neptune, its period when it had contracted to the orbit of Uranus ought to have been 67 years; at the orbit of Saturn, 16·7 years; at that of Jupiter, 4·94 years, etc., etc. This obvious inconsistency with Kepler's third law‡ has been noticed by astronomers, and recourse has been had to the additional supposition that the rate of variation of density from surface to center was continually changing through all the cycles of planetary formation.§ Till this latter hypothesis—invented to sustain the hypothesis of Laplace—shall itself have been placed on a basis of facts, the superstructure must be regarded as eminently unstable.

CONCLUSION.

It has been shown (1) that the hypothesis of Laplace gives no explanation of the immense intervals between the planetary orbits; (2) that, apart from this objection, the periods required for the formation of planets from nebulous rings are greater than the probable age of the solar system; (3) that it fails to account for the origin of satellites; and (4) that it is apparently incompatible with a known physical law. The conclusion seems inevitable that this celebrated hypothesis must yet be abandoned, or that its principal features must be essentially modified.

* Published at Paris in 1813.

† "On the only hypothesis science will now allow us to make respecting the source of the solar heat, the earth was, twenty millions of years ago, enveloped in the fiery atmosphere of the sun."—*Prof. Simon Newcomb, in the N. A. Review for July*, 1876.

‡ Let r, r', and t, t' represent the radii and periods of rotation of the solar nebula at two different epochs; then $t : t' :: r^2 : r'^2$. But by Kepler's third law, $t : t' :: r^{\frac{3}{2}} : r'^{\frac{3}{2}}$

§ See the able and interesting memoir on the Nebular Hypothesis by Prof. David Trowbridge, in the *Am. Journal of Science* for November, 1864.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50, stitched in paper, or $3.50, bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers.
37 Park Row, New York, N. Y.

TABLE OF CONTENTS.